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EDITORIAL

Diagnosis from Frozen Section in Lesions of the Breast

THE purpose of this communication is to discuss the practical application of diagnosis from frozen section of lesions of the breast in the light of long experience of a surgeon and a pathologist with a considerable interest in and familarity with this field. It is obvious that the examination by frozen section should not begin with a piece of tissue obtained from a patient and submitted to the pathologist by the surgeon. The pathologist should be familiar with the clinical data, and he and the surgeon should discuss the patient in consultation. In some instances it is important that the pathologist palpate the lesion before the operation begins. This can be most readily done in the operating room after the patient has been placed under anesthesia but before she is draped.

It is only in the exceptional case that the surgery is governed by a specific diagnosis of the lesion in question. All that the surgeon really wishes to know from the pathologist is whether he is dealing with a benign or malignant lesion.

Fortunately, benign and malignant tumors in the breast have characteristic gross features. Among common benign tumors are fibroadenomas and papillomas; among the malignant lesions, the carcinoma is by far the most common. Fibroadenomas offer little difficulty grossly. Also, papillomas can usually be diagnosed grossly. They are glossy, soft and well circumscribed and usually fill a dilated duct. Cysts, glandular hyperplasia and fibrosis are other common benign lesions. A diagnosis from frozen section seems superfluous. Such an attitude prevents certain microscopic pitfalls. Thus, a lactating fibroadenoma seen in pregnancy may present an increased cellularity and hyperchromatism which may be quite disturbing to the pathologist on frozen section. Likewise, sclerosing adenosis is a lesion which can usually be distinguished grossly from carcinoma while the diagnosis from frozen sections of such a lesion may be extremely difficult. A rare lesion which may resemble carcinoma is a granular cell myoblastoma, but the fact that it is often located very superficially may lead to a correct diagnosis. Grossly it might well be confused with a carcinoma and, in this case, diagnosis by means of frozen section seems important. Fortunately, the lesions of plasma cell mastitis, fat necrosis and organizing hematoma are seen infrequently in our experience, but also lend themselves well to frozen section when they simulate carcinoma.

Most carcinomas also have a characteristic gross appearance. Among them, good examples include the mucinous, medullary, scirrhous, and comedocarcinomas. Yet frozen sections of these tumors may lead to difficulty. The tumor cells may be compressed and completely obliterated in mucinous carcinomas. In the medullary carcinoma the associated lymphoid infiltrate may lead to a false diagnosis of lymphoma or chronic inflammation. In certain scirrhous carcinomas, a frozen section of tissue chosen from near the center may disclose only dense fibrosis with an

occasional malignant cell and may be incorrectly diagnosed. In our opinion, a gross diagnosis of these carcinomas is often adequate and prevents certain errors due to mechanical difficulties inherent in technics of frozen section or errors resulting from the selection of uninvolved areas.

It is obvious that the technic used in performing a frozen section is of utmost importance. Numerous reports in the literature demonstrate the advantages of staining, fixation or cutting technics and indicate that there is no completely satisfactory method as yet. We use iron hematoxylin, and/or thionine stains. It is our advice, however, that the pathologist should use the method with which he is most familiar.

There are, of course, lesions which are grossly suspicious for carcinoma because of their characteristic rubbery consistency, but a gross scrutiny of such lesions may fail to reveal the typical architectural changes of a carcinoma. These lesions may be very small. It is our experience that these lesions are almost invariably carcinomas. Here, only a frozen section prepared by an expert and taken from just the right spot will disclose the correct diagnosis. Frozen sections are indicated in instances of inflammatory carcinomas of the breast and are also useful in the diagnosis of Paget's disease of the nipple. There are lesions grossly quite characteristic of Schimmelbusch's disease, but which, in some areas, are composed of dilated ducts containing an inspissated worm-like material with markedly thickened walls separated from one another by thickened fibrous and sometimes hyperplastic glandular tissue which are difficult to distinguish from intraductal carcinoma. In such instances it is our policy to wait for a regular section stained with hematoxylin and eosin before making a diagnosis. This is particularly important because there is often microscopic papillomatosis which may offer great difficulties in the diagnosis even when examined in permanent sections.

From the above, it is obvious that frozen sections are not indicated in the following lesions: (1) unquestionably benign lesions, (2) unquestionably malignant lesions, and (3) small papillary lesions which are well confined to dilated ducts. It is true that by following such an approach, low grade intraductal carcinomas will be rarely missed at the time of surgery. However, we believe that it is better to be conservative in such an instance. It is, of course, imperative that the surgeon refrain from assuring the patient that she has no malignancy until the permanent paraffin sections have been examined.

When, then, is the frozen section diagnosis actually indicated? It is indicated in lesions which are suspicious for carcinoma on palpation but do not present the characteristic gross features of carcinoma. These include inflammatory carcinomas, Paget's disease of the nipple and granular cell myoblastomas. Actually the frozen section represents a consultation expressing the experience of both the surgeon and the pathologist, rather than only the examination of tissue by means of a freezing microtome and rapid staining technique. In removing the lesion in the breast, the surgeon frequently palpates an area which seems suspicious for carcinoma. Frozen sections from such areas are often rewarding. The experienced surgeon and the observing pathologist can frequently tell by the way in which the lesion is excised whether it is benign or malignant. It has been our experience that, whenever the lesion is not well circumscribed and the surgeon is unable to find a distinct cleavage between the involved and the uninvolved breast tissue, that such a lesion is almost invariably of a benign character. In our experience it is also rare for a carcinoma to be present in an obvious fibrocystic disease area of the breast.

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SCIENTIFIC PAPERS

The Bacterial Flora of the Gastric Stump

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THE content of the normal stomach is considered sterile. Bacteria from the mouth, nasopharynx, bronchopulmonary tree and ingested food are rapidly killed by the digestive enzymes and the hydrochloric acid or they are passed into the duodenum. Thus, the surgeon can open the stomach, duodenum and upper jejunum without fear of serious contamination.

Under pathologic conditions, however, the stomach harbors numerous bacteria. The flora of the stomach has been investigated by various methods. The gastric juice was collected by a gastric tube or by direct aspiration of the stomach during a surgical exploration of the abdomen. Smears were taken from the surface of the ulcer in surgical specimens or tissue from the gastric wall was cultured. Fresh autopsy material was also studied [*1*]. These and other technical details have produced some statistical differences, but the essential bacteriologic changes in the diseased stomach are fairly well documented. Two major factors are responsible for the bacterial flora in the stomach: a decreased acidity in gastric secretions and the presence of an ulcerated lesion.

A bacterial flora is more frequently associated with a gastric than with a duodenal ulcer because of the lower acidity associated with the gastric lesion. Seley and Colp [*2*] have found positive cultures in 83 per cent of gastric ulcers in contrast to 36 per cent in duodenal ulcers. The same authors obtained positive cultures in 93 per cent of cases of gastric malignancy. The bacterial flora in the case of a peptic ulcer consists mainly of gram-positive organisms, but colon bacilli were frequently found in the presence of a gastric malignancy. These findings were confirmed in the literature [*3–6*].

There seems to be general agreement that Escherichia coli inhabits the stomach in almost all instances of pernicious anemia [*7–9*] and it was frequently isolated in cases of achlorhydria as well as in various types of anemias [*10*].

The surgeon has a special interest in the microflora of the gastric stump following a partial resection since this operation is performed, in part, for the purpose of reducing gastric acidity. Seley and Colp [*2*] have found a gastric flora in all of sixty-two patients examined. E. coli was demonstrated in forty-six cases. The findings of European investigators were similar [*9,11,12*]. Little documentation was found in the American literature.

MATERIAL AND METHOD

This study was based on the bacteriologic examination of the contents of the gastric stump in thirty-five patients who had resections of the stomach. All operations were performed according to the Hoffmeister-Polya procedure. The specimens were collected through a gastric tube (supplied commercially in a sealed plastic bag) from the fasting stomach or through the tube still in place following the operation. The postoperative period ranged from twenty-four hours to ten years. In six cases, the gastric contents were examined preoperatively and several times postoperatively for a period of two months. A smear from the sediment of the centrifuged specimen was

TABLE 1
COMPOSITION OF BACTERIAL FLORA IN THE GASTRIC STUMP OF THIRTY-FIVE PATIENTS

Organism Found	No. of Patients
Alpha hemolytic streptococcus (viridans)	20
Beta hemolytic streptococcus	2
Hemolytic staphylococcus aureus	7
Non-hemolytic staphylococcus	4
Diphtheroids	6
Escherichia coli	22
Aerobacter aerogenes	9
Pseudomonas aeruginosa	5
Proteus group	5
Paracolon bacillus	1
Streptococcus fecalis	9
Gaffkya tetragena	1
Candida species	11

stained by the Gram method and examined. The cultures were made on blood-agar and Endo's agar plates.

FINDINGS

The stained smear revealed the presence of microorganisms in all cases. The abundance of the bacteria on the smear, however, did not reflect the number or the type of the colonies on the culture plates suggesting that numerous bacteria were dead. The cultures were positive in all instances. The identified organisms are listed on Table 1.

Gram-positive organisms were identified in more specimens than gram-negative bacilli. The gram-positive organisms also appeared to be more numerous in many individual specimens with a mixed flora. Organisms which were representative of the colon flora were identified in twenty-three out of thirty-five cases. The richness of the flora has varied greatly. The cause of such unpredictable differences is not evident from this study. In general, the acidity of the gastric juice is considered the most important factor in prohibiting the bacterial growth in the stomach. In this series, one specimen contained free hydrochloric acid (24 units). This specimen produced growth of a Candida species but no bacteria.

Since achlorhydria and ulcerated lesions are frequently accompanied by a bacterial flora, it is not surprising that most cultures were positive during the first twenty-four to forty-eight hours following the operation. Two specimens were sterile in the immediate postoperative period but a repeated examination produced bacterial growth five days later. Beyond this observation, the time element did not appear to be a major factor in influencing the gastric flora. We were unable to correlate the richness or the composition of the flora with the length of the postoperative period.

The partial gastrectomy was performed for peptic ulcer in thirty cases and for gastric carcinoma in five. The nature of the preoperative lesions did not appear to have an influence on the development of the bacterial flora of the gastric stump.

COMMENTS

The interest of the surgeon in the bacterial flora of the gastric stump is easily understood. Partial gastrectomy is a common operation and secondary operations on the upper gastrointestinal tract of these patients are being performed more frequently. Since the stomach, and consequently the upper jejunum, are never sterile in these patients and their bacterial flora frequently resembles that of the lower gastrointestinal tract, such operations call for special considerations. The presence of a stomal ulcer or of an ulcerated neoplasm will further increase the hazard of an infection. The presence of the Pseudomonas, Aerobacter aerogenes and the Proteus group is an added danger because of the resistance of these organisms to many antibiotics and chemotherapeutic agents. Thus, all operations on the upper gastrointestinal tract following a partial gastrectomy call for special precautions. An antibacterial preparation of the gastrointestinal tract also should be considered.

SUMMARY

The content of the gastric stump following partial gastrectomy was examined bacteriologically in thirty-five cases.

All specimens contained microorganisms. Gram-positive organisms were slightly predominant. Twenty-three of thirty-five specimens contained organisms representative of the colon flora.

A surgical intervention on the upper gastrointestinal tract following a partial gastrectomy calls for special precautions.

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The Anatomy of the Anorectum

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Few areas of the human body upon which surgery is frequently performed have caused more controversy regarding anatomic relationships, than has the anatomy of the anorectum (the distal 3 cm. of the alimentary canal). The persistence of such a controversy for over three quarters of a century after the means for its resolution were available is surprising. This study is devoted to the description of the relationships and composition of those structures which are immediately adjacent to the anorectal canal, based on findings from clinical, gross and microscopic material.

MATERIAL AND METHODS

Four types of material were employed in this study all of which were obtained from adults, Negro and white, men and women, in random order. (1) Twenty patients upon whom we performed rectal surgery at The Johns Hopkins Hospital provided an opportunity for inspection and palpation of the various structures under investigation, as well as an opportunity to partially dissect and to obtain biopsies from the internal and external anal sphincters. (2) Seventeen well preserved cadavers provided an equal number of longitudinal sections of anorectum, from which microscopic sections were stained with hematoxylin and eosin, and also by either Weigert's azure or Masson's triple chrome technic. (3) Four longitudinal sections of anorectum in the fresh postmortem state were obtained following the submucosal injection of saline or formalin, in order to demonstrate fibrous structures in the submucosal layer. These were all stained with hematoxylin and eosin. (4) Four intact specimens were obtained in the fresh postmortem state for gross dissection.

COMMENTS

This anatomical investigation was devoted to clarification of the nature and relationships of specific structures comprising the anorectum: Hilton's line, the epithelium, the anal sphincters, the longitudinal intermuscular septum, the submucosal "suspensory ligament," and the musculus submucosae ani.

HILTON'S LINE

The primary landmark of orientation for the rectal surgeon since the middle of the last century has been Hilton's white line [5]. He described this important landmark as follows, " . . . a white line . . . , which in the living subject any surgeon can recognize, . . . That white line corresponds exactly with the linear interval between the external and internal sphincter muscle. . . . That line corresponds (I have tried this several times) with the white line of junction between the skin and the internal mucous membrane." On examination of our operative cases and on gross dissection, it was never possible to find a white line at the interval between the internal and external sphincters. (Fig. 1.) This is in agreement with Ewing's earlier work [3].

The important point which Hilton made, however, is that the lower border of the internal sphincter is in fact the landmark, "which in the living subject any surgeon can recognize." It is not defined by a visible line, but it can be easily palpated. The inferior border of the internal sphincter is firm, rounded, and composed of strong circular fibers, which we were able to palpate in all instances in which it was attempted. The border of this sphincter is readily distinguished from the inferior border of the external sphincter which is more readily depressed with the palpating finger, being thinner and weaker. The external sphincter

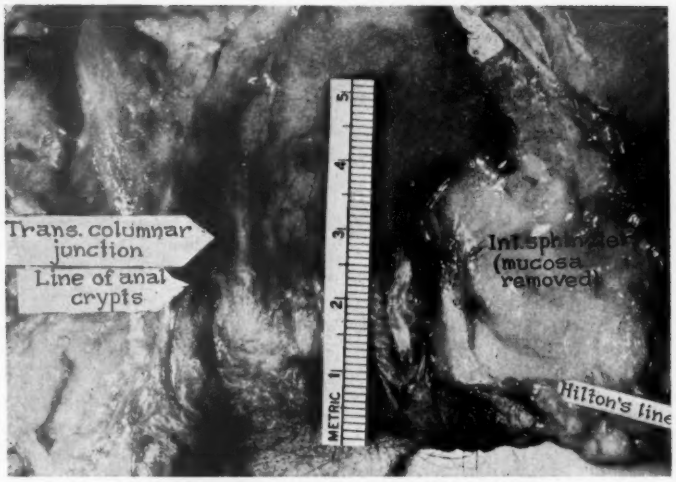

FIG. 1. Rectal canal opened in the lateral midline.

has a ribbon-like consistency, rather than the strong ring-like consistency of the internal sphincter.

On microscopic examination the epithelium overlying the inferior border of the internal sphincter is usually the site of the gradual change from true skin to the transitional epithelium. It must be recognized that Hilton's line is the fundamental landmark of the anorectum, but that it is a palpable and not a visible line.

EPITHELIUM

Progressing into the lumen, the anorectum is covered with skin, then with transitional epithelium. The latter is stratified squamous epithelium, with no skin appendages, with shallower and wider rete pegs, and having either a thin cornified layer or none at all. Finally, in its upper extent, the anorectum is lined with typical, mucous-secreting, columnar epithelium.

The region of transitional epithelium, sometimes called the pecten [9], contains the anal crypts. Tumors with distinct microscopic characteristics arise in this zone [12].

The transitional epithelium mainly overlies the internal sphincter, extending within a few millimeters of this sphincter's cephalad margin, and terminating caudally within one centimeter of the sphincter's rounded inferior border, as determined on our cases.

The transitional columnar junction is microscopically distinct and abrupt. It can be defined in the gross on postmortem specimens, as a circumferential line several millimeters above the level of the anal crypts, where the epithelium abruptly ceases to have a dull appearance and takes on a shiny appearance when viewed in oblique light. The change is sufficiently subtle grossly that we did not see it on the operative cases, which were necessarily viewed under direct light.

The anal crypts are caudally directed invaginations of transitional epithelium into the submucosa underlying the transitional zone. The crypt orifices are located circumferentially about the upper part of the transitional zone.

THE ANAL SPHINCTERS

The internal sphincter is a tubular structure composed of circularly and obliquely oriented bundles of smooth muscle, which is a thickened continuation of the internal layer of smooth muscle in the colon. In our series, it varied from 2.5 to 3 cm. in length and from 1.5 mm. to 5.0 mm. in thickness at its thickest point. This always represented a definite increase in thickness relative to the circular layer in the colon which varied from 0.5 to 1.5 mm. Measurements were made on fixed, stained microscopic sections. (Fig. 2.)

The external sphincter is a tubular structure of skeletal muscle which surrounds the internal sphincter for its entire length, and then continues to fold medially about the inferior

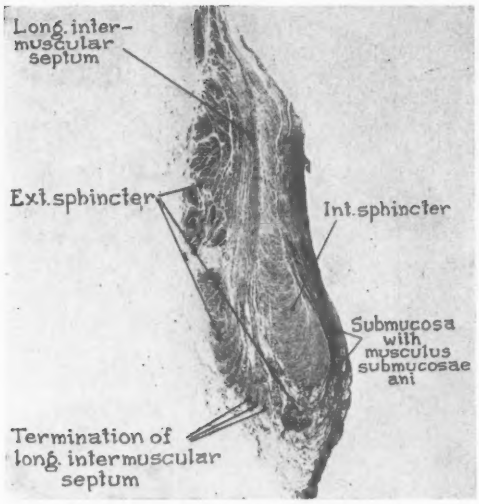

FIG. 2. Photomicrograph of a longitudinal section of the anorectum.

border of the internal sphincter where it is adjacent to the terminal portion of the lumen of the anorectum. This muscle has three parts, originally described by Santorini in 1775 (cited by Wilde [11]) and subsequently named the deep, the superficial and the subcutaneous divisions by Milligan and Morgan [6].

The classic description of these sphincters which has been the guide for many present day surgeons, is that of Milligan and Morgan, in which the diagram gives relative oversize to the subcutaneous portion of the external sphincter. This has resulted in a number of erroneous concepts which were earlier recognized in England, but which have not been generally recognized in the United States. The most important of these has been Eisenhammer's [2] recognition that the internal sphincter is primarily involved in spasm associated with an acute anal fissure, and that relief of this condition is achieved only by performing a sphincterotomy on the internal sphincter.

Surgeons attempted to determine by means of biopsies taken at the operating table, which sphincter lies in the bed of the excision of hemorrhoids, this being the same as that found in spasm in cases of acute anal fissure [10]. From fifteen of eighteen patients reported in this investigation, we obtained biopsies from what we identified to be the internal sphincter. All of these were smooth muscle. We also dissected the inferior border of what we determined to be the external sphincter and biopsy material revealed skeletal muscle.

Parks [8] conclusively demonstrated that the internal sphincter is found in the site of excision of hemorrhoids. However, we were unable to substantiate his statement that, "The internal sphincter is found to form the wall of the whole anal canal though occasionally a small bundle of the subcutaneous sphincter may occupy the terminal position." In all of our microscopic sections, as well as in three patients in whom the external sphincter was exposed at the operating table, a part of the subcutaneous external sphincter occupied the terminal position. The importance of this finding under anesthesia does not necessarily refute the work of Brossy [1]. He demonstrated that there is an intussusception of the internal sphincter through the narrow ring of external subcutaneous sphincter (which lies distal to it) during defecation or anesthesia, at which time there is general relaxation of the musculature of the pelvic floor. From our clinical observations such an evagination of the lining of the anorectal canal was regularly noted with the induction of general anesthesia. However, exposure of the external sphincter in three instances at the operating table (proved by biopsy) demonstrated it to be in the terminal position in spite of the relaxation resulting from anesthesia.

LONGITUDINAL INTERMUSCULAR SEPTUM

This fibromuscular continuation of the longitudinal coat of smooth muscle of the colon, terminates in multiple septums which divide the subcutaneous portion of the external sphincter into a number of circular bundles of muscle fibers. These septums then became progressively attenuated, with some disappearing completely and others inserting into the perianal skin. None of the fibers which terminated by passing medially about the inferior border of the internal sphincter could be traced to the skin. Furthermore, they could not be demonstrated to become continuous with fibers from the musculus submucosae ani as these fibers passed laterally from the medial surface of the internal sphincter. None of the longitudinal fibers could be traced horizontally through the internal sphincter as suggested by Wilde [11]. The longitudinal septum has only smooth

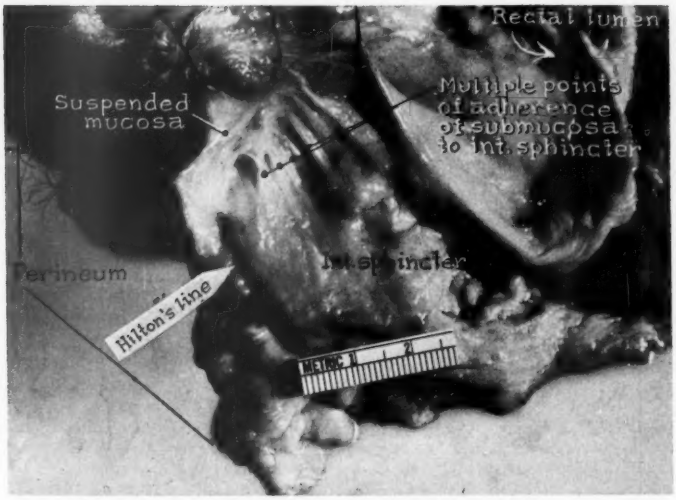

FIG. 3. Fresh postmortem specimen with the mucosa dissected from the internal sphincter and suspended to show the zone of adherence.

muscle and connective tissue components, and our sections failed to demonstrate any striated muscle [2].

SUBMUCOSAL SUSPENSORY LIGAMENT

The submucosal suspensory ligament [9] could not be demonstrated as a separate and discreet structure in any of our microscopic sections or on gross dissection of the submucosa from the underlying internal sphincter. (Fig. 3.) It appears that this "ligament" is actually the area in the anorectum at which the submucosa is most adherent to the underlying circular smooth muscle. In the same manner that the submucosa throughout the intestine is adherent in varying degrees to the underlying musculature, the circumferential zone between the internal and external hemorrhoidal plexuses at the level of the anal crypts is the region where the submucosa is most adherent in the anorectum.

Our findings support those of Fowler [4], who repeated Parks' experiments [8], injecting saline submucosally. He was consistently able to demonstrate the area of increased adherence giving rise to the interhemorrhoidal groove, but was unable to find a discreet ligament on microscopic examination of his material. The photomicrographs published by Parks [8] show a vague structure at the level of the anal crypts which he called the suspensory ligament. We could not demonstrate it, however, and Fowler [4] suggested that the structure demonstrated by Parks is actually a portion of the musculus submucosae ani.

The internal hemorrhoidal vascular plexus lies above and the external plexus below this region of greater mucosal-internal sphincter adherence. Thus the epithelium above and below has been intermittently elevated from the underlying smooth muscle by the varying states of collapse and engorgment of these blood vessels, whereas that in the region of the so-called suspensory ligament has remained adherent to the underlying internal sphincter.

MUSCULUS SUBMUCOSAE ANI

The musculus submucosae ani consists of multiple fine strands of smooth muscle, longitudinally oriented, and extending as a continuation of the musculus submucosae of the colon through the entire length of the anorectum. These fibers are present in greatest number in the deepest portion of the submucosa and are present in decreasing numbers progressing toward the epitheluim. This layer is markedly thickened relative to the corresponding layer of the colon, and it is always seen on hemorrhoidectomy since it is the only layer of muscle properly cut during this procedure.

The fibers terminate mainly in the subcu-

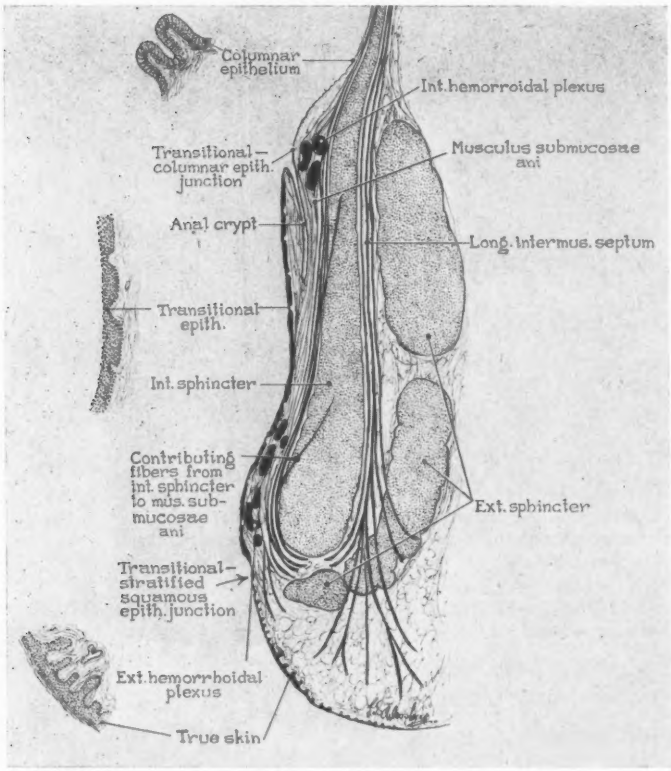

FIG. 4. Composite diagram of a longitudinal section of the anorectum.

taneous tissue of the buttock, where they become attenuated and subsequently disappear completely at the lower border of the subcutaneous portion of the external sphincter. Some of the small muscle bundles sweep laterally about the inferior border of the internal sphincter and then become attenuated and also disappear. We could not demonstrate union of these bundles of muscle as they curb the medial inferior border of the subcutaneous portion of the external sphincter with the corresponding fibers which curb the lateral inferior border from the longitudinal septum.

Occasionally, a strand of smooth muscle was found to originate in the internal sphincter and then to become part of the musculus submucosae ani. However, there was no instance in which muscular or fibrous bundles could be traced from the longitudinal intermuscular septum, horizontally through the internal sphincter and subsequently into the musculus submucosae ani, as diagrammed by Wilde [*11*] who represents this to be the primary origin of the musculus submucosae ani.

The function of this layer is undetermined, but Brossy [*1*] postulates that it acts, "to retract the anal mucosa at the conclusion of defecation."

Figure 4 represents a schematic view of our composite picture of the anatomy of the anorectum.

SUMMARY

1. Specific epithelial, muscular, and spacial relationships of the anorectum are described and illustrated.

2. Hilton's line was found to be a basic surgical landmark, but it is a palpable and not a visible line.

3. The origin, composition, and insertion of the longitudinal intermuscular septum is defined.

4. The interhemorrhoidal groove results from a submucosal-internal sphincter zone of adherence. The submucosal suspensory ligament does not exist.

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Vesicocapsular Prostatectomy

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SINCE Freyer's adenectomy several technics have been devised to resolve the problems and complications occurring during and after prostatic surgery, each of which has certain advantages or shortcomings usually related to the size and position of the prostate and the technical difficulties encountered at the time of enucleation.

All surgeons who are called upon to remove an enlarged benign prostatic adenoma, suprapubically or retropubically, are familiar with the complications and surgical difficulties with these procedures.

In the suprapubic approach, the blind and blunt enucleation of the adenoma often provokes severe hemorrhage, the control of which is often difficult or impossible because of inadequate visualization of the bleeding vessels. In these cases the surgeon must often resort to the use of hemostatic bags or packing which may endanger the integrity of the external sphincter.

In the standard retropubic method, hemostasis may be secured with greater ease, but visualization of the bladder is poor and, hence, associated disease within the viscus may be overlooked.

A combined procedure, the vesicocapsular operation, thus tends to utilize the advantages of both the suprapubic and retropubic methods and it is the purpose of this paper to present our experience with this procedure.

The technic was devised by Henrikson of Fleen, Sweden and reported by S. Hubbinette of Stockholm in 1935, and independently by Ward of London in 1948. Since then several papers have been published in which this procedure has been referred to as either the transvesicocapsular, transcommissural, vesicocapsular procedure or the like; however, these authors describe essentially the same technic. Their favorable results and specifically the adequate hemostasis which can be accomplished with this procedure prompted us to try this approach. Our results have been so satisfactory that the operation has been adapted by our department and is being performed routinely in all cases in which the suprapubic or retropubic approach is indicated.

TECHNIC

The bladder is filled with 200 cc. of sterile water through a Foley catheter which is left in the bladder. A suprapubic paramedian incision extending from immediately above the pubis to the umbilicus through skin, subcutaneous tissue and fascia is made. The peritoneum is reflected upward from the dome of the bladder and a self-retaining retractor is used to retract the tissues. The superficial veins in the anterior vesicocapsular vicinity are ligated. The bladder is emptied and the catheter is removed by the circulating nurse. The bladder is then opened with a stab wound incision just above the vesicoprostatic junction. The borders are grasped with Allis forceps and the incision is extended 2 to 3 cm. with curved scissors downward to the prostatic capsule. (Fig. 1.) All bleeding points are ligated. A holding suture is placed in the lower angle of the incision; this prevents tearing of the incision downward during the enucleation and controls bleeding of the capsular veins. The adenectomy now follows with sharp or blunt dissection according to the nature of the hypertrophy. The ejaculatory ducts and urethra at the level of the prostatic apex are severed with scissors. If subtrigonal lobes are present the enucleation starts from that point. The adenoma is grasped and pulled upward, the bladder mucosa is cut around it and a cleavage plane is obtained between adenoma and prostatic capsule. (Fig. 2.) The adenoma is then removed with the index finger by blunt dissec-

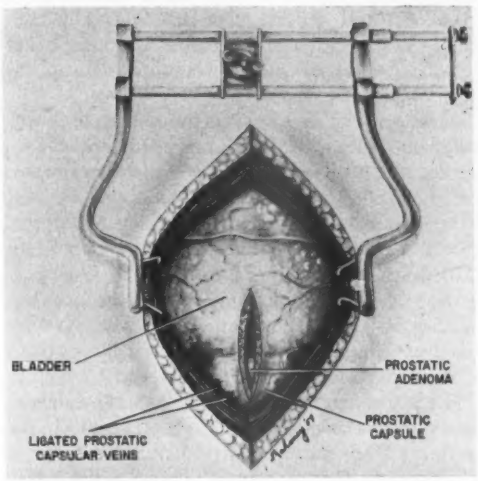

FIG. 1. Anteroposterior view shows the vertical vesicocapsular incision. Also, ligated vesicoprostatic veins are visualized.

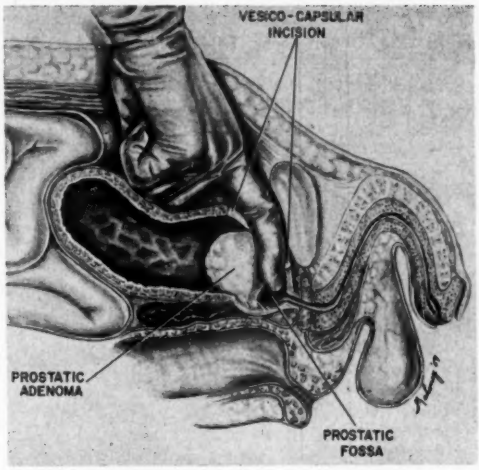

FIG. 2. Sagittal view showing the prostatic adenoma being enucleated.

tion or sharp dissection with scissors. (Fig. 3.) The vesicocapsular arteries at the vesical neck and any other bleeding vessels in the prostatic cavity are then ligated. The bladder mucosa which was cut is sutured to the prostatic capsule with No. 2–0 fine catgut in order to prevent bleeding and facilitate healing. A wedge is now removed from the posterior neck of the bladder. If any other disease of the bladder is present it is corrected before adenectomy. A No. 22 Foley catheter is inserted into the bladder through the urethra. The bag of the catheter is inflated with 30 cc. of sterile water in the bladder and not in the prostatic fossa. The incision is closed with No. 1–0 interrupted through-and-through chromic catgut sutures in a watertight manner. The catheter is now irrigated to insure absence of leakage from the suture line. A Penrose drain is left in the retropubic space and the wound is closed in the usual fashion.

POSTOPERATIVE CARE

For the first twenty-four hours and while the patient is in the recovery room the bladder is irrigated every two to three hours. If clots plug the catheter, it can easily be replaced by one of the same or of a larger size. On the first postoperative day the patient is placed on a soft diet and is ambulatory. Routinely, penicillin and streptomycin are given for five days. From then on antibiotics are not given unless infection is present. The Penrose drain is removed on the fifth postoperative day and the catheter is removed on the fifth or sixth postoperative day. Sutures are removed on the eighth postoperative day.

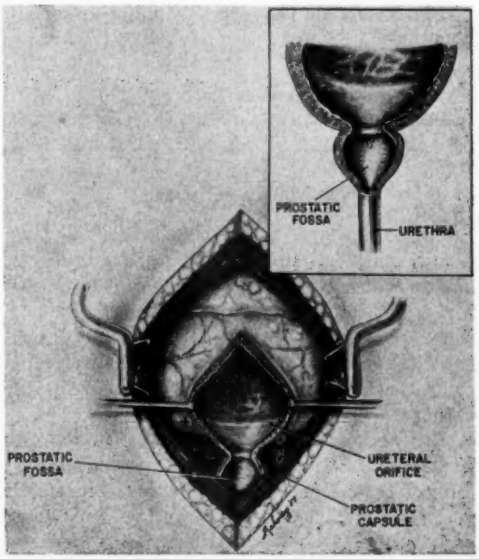

FIG. 3. Anteroposterior view showing vesical and prostatic fossa after enucleation of the gland. Dotted "V" shows the site where wedge is to be removed from posterior lip of the vesical neck.

TABLE I
COMPLICATIONS IN TREATMENT

Condition	No. of Cases
Coincidental urologic conditions	
Bilateral hydronephrosis	4
Hypertrophied interureteric ridge	2
Fibrosis of the vesical neck	1
Impaired renal function	6
Calculosis of the bladder	4
Diverticula of the bladder	2
Other systemic conditions present	
Parkinson's disease	1
Cardiac condition	26
Pulmonary tuberculosis	4
Pulmonary emphysema	7
Pneumoconiosis	1
Osteoporosis	1
Esophangeal ulcer	1
Peptic ulcer	1
Hypertension	3
Previous cerebrovascular accident	1
Diabetes mellitus	1
Psychosis	2
Paget's disease	1
Osteoarthritis	1
Postoperative complications	
Osteitis pubis	0
Immediate postoperative bleeding	2
Secondary postoperative bleeding	2
Leakage of urine through incision	2
Urinary infection	3
Temporary incontinence	3
Pulmonary embolism	1
Thrombophlebitis	1
Cerebrovascular accident	1
Wound infection	5

ANALYSIS OF CASES

The majority of patients selected had large benign glands. A small group had small fibrotic glands which would probably be better suited for transurethral resection. Primary hemorrhage occurred in two patients which was controlled by removing the clots with irrigation of the bladder and applying traction on the catheter.

The ages of the patients were as follows: five patients, or 7.8 per cent, were between forty-five and sixty years of age; thirty, or 46.8 per cent, between sixty and seventy years of age; twenty-eight, or 43.7 per cent, between seventy and eighty years; and one, or 1.5 per cent, was between eighty and ninety years. The anesthesia was used as follows: spinal anesthesia, forty-nine patients; epidural, ten patients; and general, five patients. The incidence of coincidental urologic conditions, other systemic diseases and postoperative complications is listed in Table 1.

The urinary drainage in the other cases was almost clear at the recovery room and thereafter, necessitating bladder irrigation every two to four hours on the day of the operation and afterwards twice daily until the removal of the catheter. Secondary hemorrhage occurred in two cases, the first on the fifteenth postoperative day, subsiding on bedrest alone; the second on the twenty-third postoperative day necessitating hospitalization for three days and reinsertion of a Foley catheter. Catheters had to be reinserted for a few days in two cases because of suprapubic leakage of urine. Three patients had postoperative dribbling for approximately two months which subsided spontaneously. Osteitis pubis, which we have seen on retropubic prostatectomy in which the surgical manipulations are performed closer to symphysis pubis, did not develop in any patient. Pulmonary embolism, thrombophlebitis and cerebrovascular accidents were non-fatal surgical complications in three of our patients. All patients of this group were followed up for three months postoperatively in the outpatient clinic and by the end of this period all of them were urinating easily with good control and no residual urine. Calibration of the urethra failed to disclose any stricture.

ADVANTAGES

This technic gives good and adequate exposure of the operative field and close and direct vision of the prostatic cavity and bladder. The preliminary ligation of the superior capsular veins and bleeding vessels from the incisional borders allows the surgeon to remove the adenoma in a clean, non-bleeding field. After removal of the prostatic adenoma, the vesicocapsular arteries which are located in the level of the vesical neck between 9 and 11 o'clock on the right side and 1 and 3 o'clock on the left side, can be immediately and easily ligated. Any other bleeding vessels in the prostatic cavity or bladder mucosa can be ligated, thereby accomplishing complete hemostasis. The removal of the adenoma is anatomic and complete, and any prostatic tag remaining attached to the prostatic capsule can be easily seen and removed. During enucleation the urethra is severed at the level of the prostatic

apex with a long curved scissors, thus avoiding injury to the external sphincter by excess pressure or pulling.

ADVANTAGES OVER RETROPUBIC PROSTATECTOMY

This operation can be performed on obese as well as thin patients. The incision in the vesicocapsular junction is vertical. Therefore, the superior oblique and lateral prostatic veins of Santorini's plexus are not severed. This results in less bleeding and makes coagulation of these veins unnecessary, thus preventing a secondary hemorrhage.

If any disease is present in the bladder such as a hypertrophied interureteric ridge, calculi, tumor, or diverticula, they can be easily corrected by extending the incision upwards as far as is necessary for good exposure. There is no need to pack the lateral prostatic fossa.

In retropubic prostatectomy during the enucleation of large adenomas the capsule tears laterally at the angles of the incision which results in bleeding, thus making closure difficult. Also, the removal of a wedge from the posterior vesical neck is more difficult because of inadequate vision and exposure.

SUMMARY

Sixty-four vesicocapsular prostatectomies were performed. The characteristic features of the technic are as follows: (1) adequate exposure with direct vision of the prostatic cavity and bladder; (2) less bleeding during surgery and excellent hemostasis; (3) other disease in the bladder may be visualized and corrected during the procedure; (4) greater protection of the external sphincter; (5) adenectomy is anatomic and complete; (6) patients require less hospital and nursing care; and (7) subtrigonal adenomas and obstructions of the vesical neck can be easily removed under direct vision.

Acknowledgment: We are grateful to Dr. Edmund J. Daly, Chairman of the Urological Department, for his encouragement and constructive criticism and to Mr. Felix Traugott, Medical Illustrator of Medical Center, Jersey City, New Jersey.

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Fat Embolism and a Fat Center

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FAT embolism is recognized as a frequent cause of death following severe injury, accompanied by fractures, severe crushing, etc. Careful search also discloses the presence of fat embolism in death from many other diseases. Unfortunately, the routine methods of preparation of tissue for section removes fat, and unless special technics such as frozen sections are used, the presence of fat is unknown.

My misgivings regarding the theory of "the origin of fat from fractured bones" was further supported by the death of two patients from fat embolism in whom no injury in the form of violent trauma and fractures was found. The basis for the concept may be explained by citing one case.

The patient had anaphylactic reaction with shock. With resuscitative measures, she survived for a week, during which time she showed increasing evidence of renal insufficiency. Clinical tests showed the presence of fat in the blood, sputum and urine. At postmortem examination there was diffuse fat embolism in the kidneys, lungs, heart and cortical vessels of the brain. In this case whether the fat was a concomitant finding or the condition precipitating the fatal issue, is not proved; however, the total pathologic findings were typical of fat embolism and of such a degree as to cause death in parallel cases in which trauma had been the exciting cause.

With this further evidence to support the idea that fat in fatal fat embolism might be derived from areas other than bones, a program of investigation was begun.

As shock is a factor at some stage in most patients dying of fat embolism, it was decided to investigate whether shock alone might produce fat embolism. We tried to reproduce fat embolism in dogs with peptone shock and met with only moderate success.

The work by Claude Bernard demonstrated the presence of a diabetic center in the floor of the fourth ventricle which controls the metabolism of carbohydrates. He found that stimulation of this center caused almost instantaneous mobilization of carbohydrates. Other centers have been discovered, all of which suggests that the more we learn about physiology, the more we find that each broad physiologic function such as metabolism of carbohydrates, cardiovascular function and respiration are all under some supreme control.

It seemed reasonable that perhaps fat might be under the control of a center simulating those found for other functions. Perhaps when fat is ingested it is not left to chance which portion will be used for energy or which will be stored permanently. The mechanism for storing fat, mobilizing it and using up its stores is still to be discovered.

Considering these possibilities, a search for evidence of the existence of such a centre was begun. For practice, the experiments of Claude Bernard were repeated in which by piqûre we were able to stimulate a site in the floor of the fourth ventricle which gave an immediate rise of blood sugar. (Fig. 1.) By going farther forward into the hypothalamus and exploring throughout the corpus striatum, we eventually touched an area, the mechanical stimulation of which caused a rapid and distinct rise in the level of fat in the blood stream of a rabbit. (Fig. 1.)

Up to this time, the approach was made through the foramen magnum and consistent response was obtained when the needle was passed to a depth of 4.75 cm. To get better access and to try to localize this area more accurately, the parietal bones of the rabbit were removed and the hypothalamus was explored from the parietal region through the longitudinal fissure with the point of a needle passed through the corpus callosum. The accompanying diagrams show the area in which puncture in repeated experiments consistently

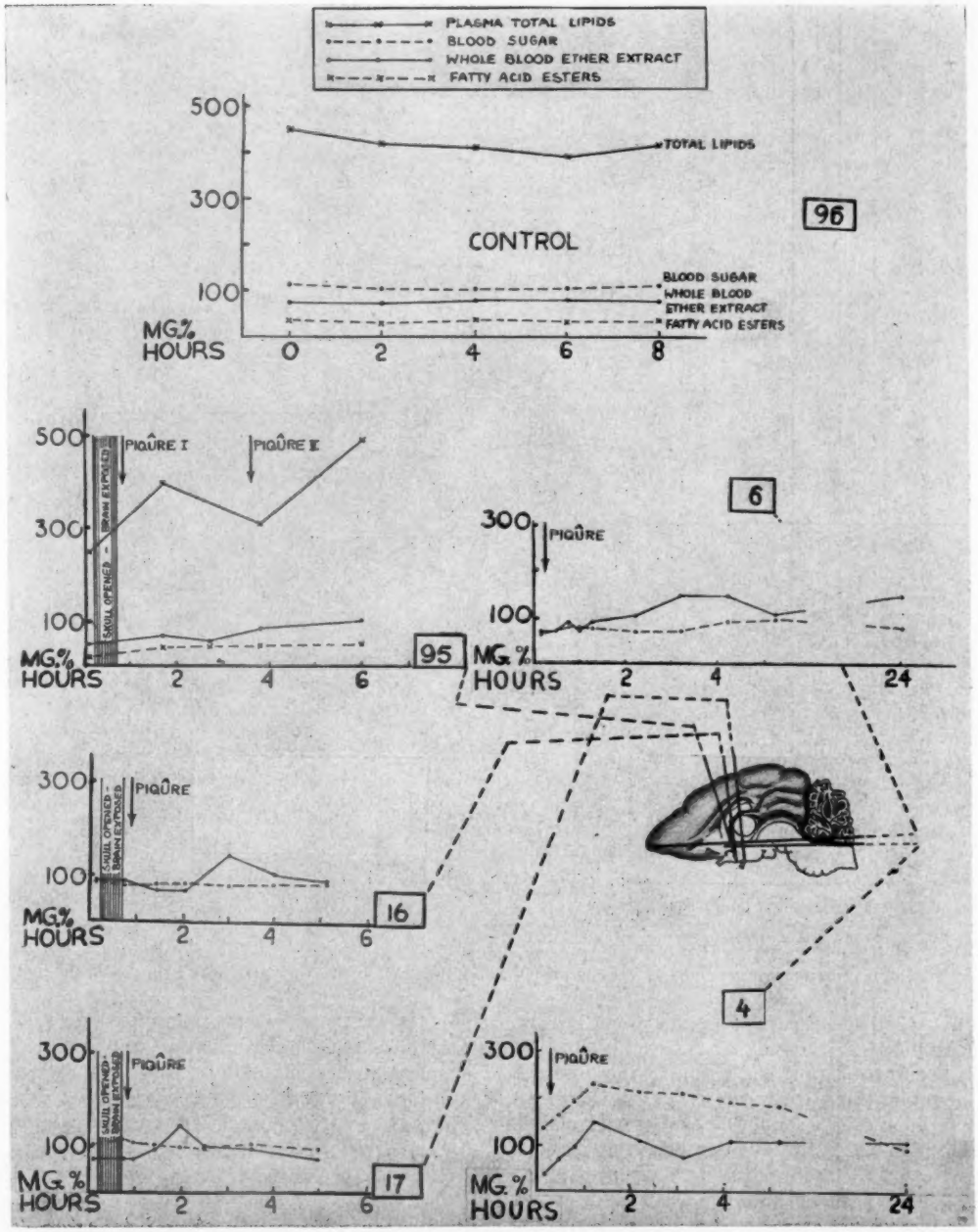

FIG. 1. Results of transforaminal and transcorpus callosum piqûres on blood lipids in the control experiment.

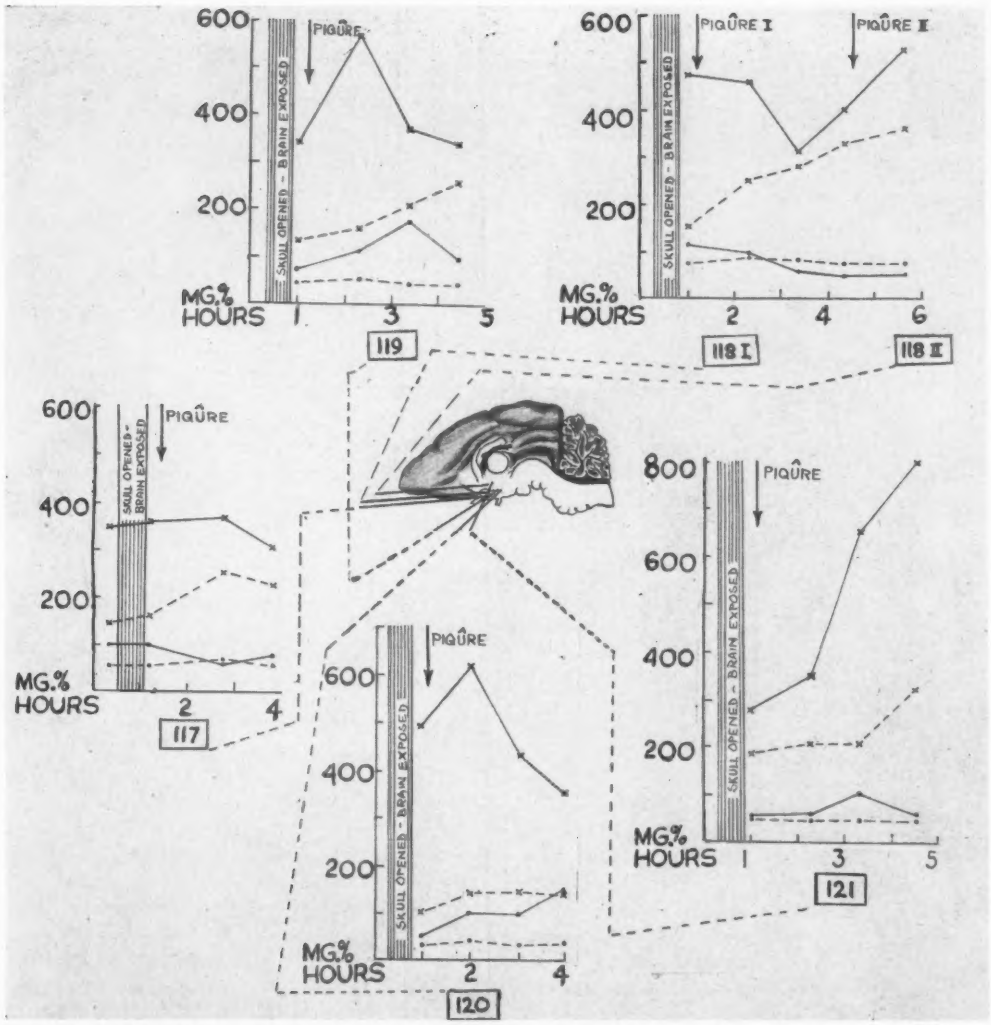

FIG. 2. This shows the results at various sites of piqûre through inferior surface of the hypothalamus.

gave a great rise of fat in the blood stream. (Fig. 1.)

From the approach through the foramen magnum, the diabetic center was in the direct line of approach and was always stimulated. Through the parietal approach, the diabetic center could be missed completely causing no rise in blood sugar; however, there was always a distinct and specific rise of fat alone. Electrical stimulation produced similar effects. (Fig. 1.)

By lifting the frontal lobes the inferior surface of the brain was exposed. By exploration from this surface with the point of a needle, an area was found the stimulation of which gave a sharp rise in blood fat. This well defined point was placed in the mid-line about 2 mm. above the inferior surface of the hypothalamus and mid-way between the optic chiasma in front and the stalk of the pituitary behind. (Fig. 2.) An area located more anteriorly significantly gave a drop in blood fat.

Short clippings of wire were pushed through a hypodermic needle which had been placed at the spot giving the characteristic rise in blood

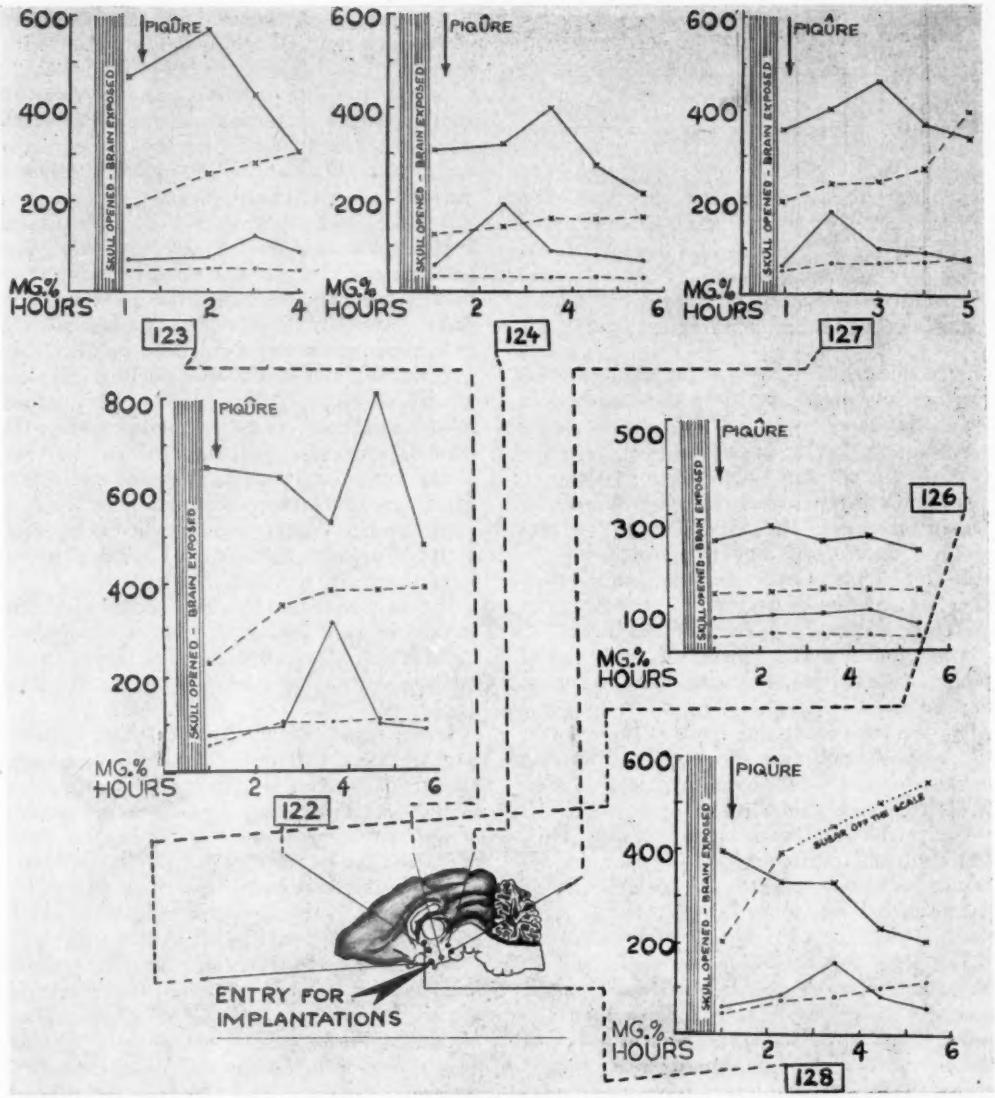

FIG. 3. This shows the verification of correlation of sites of piqûre and results by implantation of metal seeds.

fat. With the clippings of wire remaining at this point it was easy to demonstrate that the areas reached by the different approaches, the foramen magnum and the superior and inferior surfaces, all corresponded. (Fig. 3.)

To get a rough estimate of the change in level of blood fat we first used an osmic acid stain of ether extract of a measured quantity of the rabbit's blood before and after piqûre. As there was constant evidence of the existence of the center, the more accurate method of weighing ether alcohol then chloroform methanol extracts of samples of plasma and blood were used, as shown in Figures 1, 2 and 3. The complex chemistry of fats and the assessments of the proportion of fatty esters to total fats has been left to the chemists. In the graphs, however, the effects of stimulation of the center

TABLE I
EXPERIMENTS IN DOGS SHOWING THE MAXIMUM VARIATION IN PLASMA LIPID VALUES

No. of Experiments	Type of Experiment	Maximum Variation (mg. %)
6	Controls	150
11	Contusions	400
3	Contusions using acetylcholine	400
6	Contusions using eserine	150
2	Hemorrhages	150

on the different fractions of fat are indicated. Further investigation will be required to find which fraction or whether the total fat is involved in clinical fat embolism.

With the constant effect in many experiments of a rise in blood fat by piqûre of the area now labelled the "fat center," the next group of experiments were designed to investigate the effects of other types of stimulation. Local application of citric acid, boric acid and molybdic acid had no effects on blood fat.

With tourniquets in place the hind legs of rabbits were severely contused. This procedure in itself did not change the blood fat; however, when the tourniquet was released there was a sudden fairly sharp rise in blood fat. If eserine or acetylcholine were given, there was, in contrast, little and in some cases no rise of the fat.

Under the conditions previously described, i.e., contusion, specimens of organs were removed for biopsy. In general, after a significant rise in blood fat, more fat was visible with stain, in the lungs, kidneys and liver.

The next experiments were performed to investigate various substances which might possibly have some effect in controlling the rise of blood fat induced experimentally. It was theorized that an appropriate drug might attack the fat center and thereby reduce the fat level in a patient once it had risen following an accident. This might be some protection against the late and fatal effects of fat embolism. Better still, perhaps a suitable drug might narcotize the fat center, and if given before the crushing object was removed, it might prevent the rise of blood fat and consequently the dire effects of fat embolism. Again, local application of citric acid, boric acid and molybdic acid had no effects on blood fat.

To explore these avenues the leg crushing experiments were repeated and various drugs were given both before in some, and after in others.

It was interesting that therapeutic doses of acetylcholine in rabbits had some effect in reducing the blood fat after the initial rise following piqûre. If given before piqûre the blood fat was suppressed somewhat.

Eserine had more striking effects than acetylcholine. Eserine caused a striking depression of blood fat whereas adrenalin, atropine, pituitrin, dehydroergotamine, morphine and hyoscine given locally and intravenously in therapeutic doses had no effects on blood fat.

It was realized that the results of the experiments previously described in herbivorous rabbits might not parallel those in carnivorous animals when the food ingested, unlike that of the rabbit, contains large quantities of fat. Moreover, fat in carnivorous animals forms a larger proportion of the source of energy and is stored in greater quantity. The experiments were, therefore, repeated in dogs.

It was found that piqûre, hemorrhage and contusion gave blood fat results resembling those in herbivorous animals. The biopsy specimens of organs, however, had quite a different appearance.

It is common knowledge that fat, in keeping with the dietary habits of carnivorous animals, appears in greater abundance in organs such as the liver and kidney. In the stained section of the latter organ, there is normally a flash of stained fat in the mid-tubular region. However, we were convinced that there was an increase of fat in the organs of animals in which the blood fat showed a good response.

Several dogs had severe oliguria, malaise and cerebral symptoms with twitchings and incoordination, but none died of fat embolism. Several animals were followed up for eight days during which time the blood chemistry returned to normal and the animals to good health.

It was very impressive to see the striking effects of eserine in parallel experiments. It prevented the rise of blood fat, it decreased deposition of fat in organs and prevented clinical symptoms. (Table I.)

The effects of shock from hemorrhage and intestinal obstruction were also studied, but the results so far were not conclusive. More experiments must be performed.

This evidence was obtained from 150 experi-

ments in rabbits and twenty-nine experiments in dogs. Obviously, it must be repeated in other species.

In the clinical problem of fat embolism, it is postulated that perhaps the stimulation of this center with the liberation of fat may be the important feature in causing fat embolism. This may be caused by severe trauma in which fractures frequently occur, but the fractures may be only coincidental. Shock, severe illness, severe toxemia, etc., in our early experiments appear to be adequate stimuli affecting the fat center, causing mobilization of fat. In further experiments we hope to test other drugs and various inhibitors and stimulants which might be used clinically to ablate or put this center at rest in case of shock, severe fracture, or other severe injury or diseases in which the possibility of fat embolism arises.

This investigation is in its preliminary stages and is reported only to stimulate further interest in this unexplored field. Some useful applications might readily be discovered, but the enormous field will require the combined efforts of many workers.

CONCLUSIONS

From experiments in rabbits and dogs we have evidence that there is a fat center in the hypothalamus which, under the conditions described, has an influence on the level of blood fat. Investigation has demonstrated a few conditions and substances that influence blood fat levels and perhaps influence the function of the center.

Acknowledgment: This investigation was performed with the kindly interest and generous financial support of Mr. Percy Gardiner in the institute that bears his name. We also wish to thank Dr. Walter Roschlau, Miss A. Graves, B.S., and Mr. Cecil Wilding for their assistance.

Lower Extremity Amputations in Peripheral Vascular Disease

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IN recent years the dread mortality rate associated with gangrene of the lower extremity due to peripheral vascular disease with or without diabetes has been markedly reduced. Consequently, the surgeon's attention has, in many instances, been focused on attempts to preserve length in the extremity by performing a more conservative amputation, and ultimately to rehabilitate the patient. Unfortunately, however, this attitude is not by any means universal; there still persists a considerable weight of opinion of physicians who believe that at the onset of gangrene the elderly patient with peripheral vascular disease should be treated by a mid-thigh amputation and that the chances of rehabilitation to the point that the patient may walk with a prosthesis are nil.

A review of the literature indicates that numerous attempts have been made to conserve length of the lower extremity with striking success. Shumacker and Moore [1] in 1951 reported 128 consecutive leg and thigh amputations performed on 113 patients with obliterative arterial disease. Of these 128 amputations, sixty-one were performed below the knee with a mortality rate of 6.6 per cent. Of the fifty-eight patients who survived a sufficient duration of time to evaluate, fourteen had difficulty in healing of the stump and five of these required reamputation. In 1953 Edwards and Linton [2] reported a series of 221 amputations of which sixteen were below the knee. Of these sixteen amputations below the knee, thirteen healed satisfactorily, and twelve of these patients were able to wear a prosthesis satisfactorily. Silbert and Haimovici [3] in 1954 reported a series of 455 major amputations of which 331 were in the mid-leg and forty-three in the mid-thigh. In the mid-leg amputations a mortality of 7 per cent was noted. One hundred eighty-three mid-leg amputations were closed primarily and 170 of these, or 93 per cent, eventually healed. Kelly and Janes [4] in 1957 reported a series of 323 amputations of which 114 were above the knee and 131 were below the knee. Of the 131 amputations below the knee, there were forty-one wound complications, ten of which were minor and thirty-one major. Nine patients with major wound complications required reamputation above the knee and thirteen required surgical revision. There was a total of twenty-two patients with delays or revision, and of these thirteen were able to use a prosthesis satisfactorily. In their series, there was a total of fifty-two of 126 patients with amputations below the knee who were able to use a prosthesis satisfactorily as compared with eighteen of 112 patients with amputations above the knee. In 1956 Kendrick [5] reported a series of fifty-one amputations below the knee in which he obtained a rate of 63 per cent (or thirty-two patients) with first intention healing. Eleven patients had delayed healing, and in three the amputation stump was refashioned; two amputations below the knee failed and amputation had to be performed above the knee; three patients died before healing was complete. Carney and Goldowsky [6] reported thirty-eight amputations below the knee of which twenty-seven, or 71 per cent, were successful. They also reported ten closed transmetatarsal amputations, of which only two, or 20 per cent, were successful. Their study largely concerned the cost of hospitalization and length of stay for patients undergoing amputation for peripheral vascular disease, and from their data they warned against unrealistic conservative surgery. Pedersen and Day [7] in 1956 recorded a series of

TABLE I
AMPUTATIONS OF THE LOWER EXTREMITIES FOR PERIPHERAL VASCULAR DISEASE

Type of Amputation	No. of Cases
Toes	21
Transmetatarsal	9
Syme's	1
Below knee	28
Knee disarticulation	1
Above knee	68
Hip disarticulation	1
Total	129

TABLE II
CAUSES OF AMPUTATIONS FOR PERIPHERAL VASCULAR DISEASE

Cause	No of Patients
Arteriosclerotic vascular disease	87
Thromboangiitis obliterans	3
Diabetes mellitus	3
Arteriosclerosis and trauma	2
Following accidental ligation of popliteal artery	1

thirty-three transmetatarsal amputations in thirty patients. Of these thirty-three amputations, there were ten with primary healing, fifteen with secondary healing, two which were still healing at the time of report, and six failures which required reamputation.

In an effort to obtain further statistical insight into this problem, an analysis was made of the amputations performed on the Surgical Service of the Philadelphia Veterans Administration Hospital for peripheral vascular disease, from February 2, 1953, to June 6, 1958. It was also thought that follow-up study of these patients would indicate not only the feasibility of providing the elderly amputee with a prosthesis, but also would indicate to some extent the wisdom of supplying a prosthesis to these patients as judged by their subsequent use of the artificial limb. Amputations performed primarily for infection, trauma, or tumor were excluded from the study.

In the four years and three months of the study, there was a total of ninety-six patients who had one or more amputations of the lower extremities for peripheral vascular disease. One hundred twenty-nine amputations were performed on these ninety-six patients. Removal of multiple toes at one operation was considered as only one amputation. Of these ninety-six patients, ninety-five were men and one was a woman; seventy were white and twenty-six Negro. Table I gives the breakdown of the various amputations performed. It may be remarked at this point that in recent years there has been an increased tendency to attempt conservative surgery. Table II lists the diagnoses that were made in these ninety-six patients. It will be seen that the great majority were due to arteriosclerosis with or without concomitant diabetes. Only three were clinically diagnosed and proved on pathologic examination to be due to thromboangiitis obliterans. In three cases it was believed that diabetes itself was mainly responsible for the gangrene, with arteriosclerosis a minor or insignificant factor. One patient was admitted with gangrene following accidental ligation of

TABLE III
INCIDENCE OF DIABETES MELLITUS IN AMPUTATIONS DUE TO PERIPHERAL VASCULAR DISEASE

Status	No. of Patients
No diabetes	52
Diabetes present	44
Controlled by diet	9
Using no more than 20 units of insulin daily	15
Using more than 20 units of insulin daily	20

TABLE IV
INCIDENCE OF OTHER SERIOUS DISEASES IN AMPUTEES DUE TO PERIPHERAL VASCULAR DISEASE

Type of Disease	No. of Cases
Cardiovascular	45
Pulmonary	5
Genitourinary	12
Gastrointestinal	5
Neuropsychiatric	20
Ophthalmologic	9
Contracture of the joints	4
Miscellaneous	18
Total	118

TABLE V
COMPLICATIONS FOLLOWING AMPUTATION FOR PERIPHERAL VASCULAR DISEASE

Type of Complication	No. of Cases
Wound	58
Cardiovascular	6
Pulmonary	7
Genitourinary	3
Neuropsychiatric	1
Other	3
Total	78

NOTE: There were no complications in sixty of the ninety-six patients.

the popliteal artery performed elsewhere, and in two patients it was judged that a relatively equal responsibility for gangrene was to be shared by both trauma and arteriosclerosis. Eighty-seven patients had a complete follow-up study either to the time of their death or to the writing of this report. Of the remaining nine patients four were subsequently rehospitalized, leaving only five who were not followed up at all. The rate of follow up was 94.8 per cent.

It was interesting to observe the relationship of diabetes to gangrene, as seen in Table III. In fifty-two patients, no diabetes was evident. In the remaining forty-four, moreover, nine had diabetes which was controlled solely by diet, and fifteen had diabetes which required no more than 20 units of insulin daily. Only twenty patients needed more than 20 units of insulin daily. It was our impression that the presence or absence of diabetes did not materially affect either the morbidity or mortality rates, the level of amputation, or the success of amputation.

The incidence of significant systemic disease in our patients was quite high as seen in Table IV, which shows that 118 disease categories, exclusive of diabetes, were listed for this series of ninety-six patients. Only thirteen patients had neither any evidence of diabetes nor any evidence of other serious disease. In nineteen patients, the other extremity was described as being in poor condition, and in twenty-seven patients the other extremity had already undergone a minor or major amputation. Nevertheless, in sixty of the amputations performed, no complications followed. Table V lists the complications that were encountered.

In order to evaluate the results of the various types of amputations, it seemed more logical to consider the individual amputation rather than the individual patient. Table VI itemizes the types of amputations performed during this period and lists the results obtained with each type of amputation. Over-all operative mortality rate was 10.1 per cent; all patients who died as a result of surgery or within thirty days of surgery were considered operative

TABLE VI
RESULTS OF AMPUTATIONS FOR PERIPHERAL VASCULAR DISEASE

Amputations	Total No.	No. of Failures and Incidence (%)	Operative Deaths and Mortality Rate (%)	Wound Complications Other than Failures		No Wound Complications or Failures
				Treated Conservatively	Treated by Surgery	
Toes	21	6 (29)	0 (0)	1	3	11
Transmetatarsal	9	6 (67)	1 (11)	2	0	1
Syme's	1	1 (100)	0 (0)	0	0	0
Below knee	28	9 (32)	2 (7)	4	3	12
Knee disarticulation	1	1 (100)	1 (100)	0	0	0
Above knee	68	10 (15)	9 (13)	7	8	43
Hip disarticulation	1	0 (0)	0 (0)	1	0	0
Total	129	33 (25.6)	13 (10.1)	15	14	67

NOTE: Operative deaths are ascribed only to original amputations.

TABLE VII
SUBSEQUENT COURSE OF AMPUTATION FAILURES

Amputations	No. of Failures	Higher Amputation Successful	Fitted with Prosthesis	Died	Treatment Incomplete*
Toes	6	5	4	0	1
Transmetatarsal	6	5	3	1	0
Syme's	1	1	1	0	0
Below knee	9	7	3	2	0
Knee disarticulation	1	0	0	1	0
Above knee	10	0	0	10†	0
Total	33	18	11	14†	1

*Signed out of the hospital against medical advice.
†One death is considered twice. both under knee disarticulation and under above the knee amputation

deaths. Table VII complements Table VI in that Table VII describes the subsequent course of those amputations that failed. Worthy of note is the high failure rate of transmetatarsal amputations with one operative death; in the other five failures following this operation amputations were successfully performed at a higher level. The failure rate in toe amputations is not unexpected, but it is significant that in five of the six failures a higher amputation was successful, and the remaining patient left the hospital against medical advice. One Syme's amputation was performed during this period for peripheral vascular disease and failed. It may be noted, however, that subsequent to the conclusion of this study, another Syme's amputation was performed for thromboangiitis obliterans with success. Our failure rate of 32 per cent for below knee amputations fairly closely corresponds to some of the reports in the surgical literature. The one knee disarticulation, as might be expected, also failed. The hip disarticulation was believed at the time to be necessary because of the extremely extensive nature of the gangrenous process. Fortunately, it succeeded.

The charts of the thirty-three amputation failures were also reviewed (Table VIII) in an attempt to relate the adequacy of the circulation as seen at the operating table to the incidence of failures. In fifteen of these patients the status of the circulation at the time of the original operation was not stated. In ten patients, the circulation was described as either absent, poor, or minimal, and fair in five cases. In only three amputation failures was the circulation described as good. In addition, two other amputations succeeded after the site of amputation was changed to a higher level at the operating table because of the inadequacy of the circulation at the first level selected. The possible benefits of sympathectomy either prior to amputation or simultaneously with the amputation could not be statistically demonstrated, nor could it be shown whether or not a contralateral sympathectomy was efficacious in preventing later catastrophe in the opposite leg.

TABLE VIII
STATUS OF CIRCULATION IN AMPUTATION FAILURES AS RECORDED BY SURGEON

Data	Number
Not stated	15
Absent, minimal, or poor	10
Fair	5
Good	3
Total	33

Table IX demonstrates the parallel relationship between the patient's age and mortality following amputation, and an inverse relationship between age and ability to fit with a prosthesis. A prosthesis was considered "indicated" in all patients who survived operation and whose level of amputation required a prosthesis. In younger patients, the mortality was zero and all of the survivors were fitted with a prosthesis. In patients between the ages of forty and seventy years, the mortality figures per decade ranged between 8 and 14 per cent and approximately two-thirds of the patients

TABLE IX
RELATIONSHIP OF AGE TO MORTALITY AND ALSO TO CAPACITY TO BE FITTED WITH PROSTHESIS

Age	No. of Patients	Mortality (No. and %)	No. of Patients in Whom a Prosthesis was Indicated	No. of Patients Receiving Prosthesis	Per cent of Prosthesis in Suitable Patients
20–30	1	0 (0)	1	1	100
31–40	6	0 (0)	3	3	100
41–50	7	1 (14)	5	3	60
51–60	24	2 (8)	21	15	71
61–70	49	6 (12)	34	21	62
71 and over	9	4 (44)	5	0	0
Total	96	13 (13.6)	69	43	62.3

TABLE X

SUITABILITY OF VARIOUS AMPUTATED STATES FOR PROSTHESIS

Final Status	Total No.	No. Receiving Prosthesis and Per cent	Reasons for Not Getting Prosthesis					
			Not Indicated	Death	Declined	Age	Physical Disability	Unknown
Toes	14	0 (0)	14	...	...	...	...	...
Transmetatarsal	4	1 (25)	2	1	...	...	...	...
Below knee	14	12 (86)	...	...	1	1	...	...
Above knee	47	24 (51)	...	10	...	2	9	2
Bilateral below knee	1	1 (100)	...	...	...	...	...	...
Bilateral above knee	15	3 (20)	...	3	...	...	5	4
Above knee and below knee	5	2 (40)	...	2	...	...	1	...
Bilateral hip disarticulation	1	0 (0)	...	...	...	...	1	...
Total	101	43	16	16	1	3	16	6

could be fitted with a prosthesis. Finally in the elderly patient over seventy, there was a mortality of 44 per cent, and none of the survivors were successfully fitted with a prosthesis. Overall mortality rate of patients was 13.6 per cent, using the criteria for an operative death described previously.

Table X correlates our ability to provide prostheses for our amputees with their final amputated state. A word of explanation is perhaps in order. To evaluate this subject, it was necessary to consider the individual patient as he reached a final or conclusive status and was either transferred, discharged, or dead. On 101 such occasions, a patient reached a final disposition and was either considered for a prosthesis or had died of the disease or from surgery. The results are itemized in Table X by the patients' final status. The sixteen deaths include the thirteen operative deaths and three others more than thirty days after amputation from causes unrelated to surgery. It will be seen, of course, that patients with toe amputations were not fitted with a prosthesis inasmuch as a prosthesis was not indicated. One patient with a transmetatarsal amputation was fitted with a prosthesis, although this is not our usual policy. The benefits of performing a successful amputation below the knee are evident in that twelve of fourteen such patients were fitted with a prosthesis, and of the remaining two, one was not fitted because the patient declined. Twenty-four, or 51 per cent, of forty-seven patients with amputations above the knee were fitted with a prosthesis, including in the over-all figure, ten who were not fitted because they had died before an opportunity was present for fitting. One patient with a bilateral amputation below the knees was successfully fitted. Extremely interesting is the fact that three of fifteen patients, or 20 per cent of those who had bilateral above knee amputations, were successfully fitted with prostheses. Two of the five patients who had an amputation below the knee on one side and an amputation above the knee on the opposite side were fitted with prostheses. The patient with bilateral hip disarticulation was not provided with a prosthesis.

As stated previously, 94.5 per cent of all patients were followed up either by personal interview, correspondence, or subsequent hospitalization. Table XI illustrates the end results of those patients who were successfully fitted with a prosthesis following amputation. The average duration of follow-up study in each category and the per cent followed up are indicated. The column labelled unknown is largely comprised of patients whose questionnaire was returned with the notation of having died and no other information recorded. It will be observed that the one prosthesis issued for a transmetatarsal amputation was used, but the result was poor. This patient was subsequently rehospitalized for correction of an ulcer on the distal end of the transmetatarsal amputation stump which was believed due to the prosthesis. This ulceration has subsequently

TABLE XI

FOLLOW-UP RESULTS IN AMPUTEES FITTED WITH PROSTHESIS

Prosthesis	Total No.	No. of Patients Followed Up and Per cent	Average Duration of Followup (mo.)	No Use	Further Disabling Amputation	Unknown	Results with Prosthesis Used			
							Poor	Fair	Good	Excellent
Transmetatarsal	1	1 (100)	9	...	...	...	1	...	...	...
Below knee	12	11 (92)	34	...	1	1	...	1	7	1
Above knee	24	24 (100)	28	1	...	8	...	11	2	2
Bilateral below knees	1	1 (100)	48	...	...	...	...	1	...	...
Bilateral above knee	3	3 (100)	32	...	...	2	...	1	...	...
Above knee and below knee	2	1 (50)	13	1	...	...	...	...	...	...
Total	43	41 (95)	29	2	1	11	1	14	9	3

healed and the patient has been instructed in the use of the extremity without a formal prosthesis. Eleven of the twelve patients who were successfully fitted with a prosthesis below the knee were followed up for an average duration of thirty-four months. Of these eleven patients seven were said to have obtained a good result, one fair and one excellent. The adjectives fair, good and excellent are relative and refer to rather broad and overlapping groupings. A result was considered fair when the patient can wear the prosthesis most of the time, can walk one to two blocks with or without a cane, has not returned to work, and may have moderate phantom limb discomfort. A result was considered good when the patient wears his prosthesis all the time, can walk two to six blocks, has minimal discomfort, but has not returned to work. A result was considered excellent when the patient has minimal phantom sensation, has somewhat greater exercise tolerance and has returned to work. All twenty-four patients who received a prosthesis above the knee were followed up for an average duration of twenty-eight months. One had no use of the prosthesis, eleven were considered to have had a fair use, two good and two excellent; eight were listed on the follow-up questionnaire as having subsequently died without any further information. The one patient who had the bilateral amputation below the knee was followed up for forty-eight months and has fairly good use of his prosthesis. All three patients with bilateral prostheses above the knee were followed up for an average duration of thirty-two months and can be considered to have had a fair result. Of the two patients who were fitted simultaneously with one prosthesis above the knee and the other below the knee, only one was followed up for thirteen months and reported no use of the prosthesis.

COMMENTS

This consecutive series of ninety-six patients with 129 amputations represents the efforts of one Veterans Administration Hospital with a four-year surgical residency program to cope with the problem of treating the end result of advanced peripheral vascular disease. It is believed that the very nature of the institution from which these data are obtained provides some additional points of interest and interpretation. Despite some change in personnel and the rotation of teaching appointments among several medical schools, nevertheless there has been, in the main, a reasonably consistent surgical policy pertaining to the problem of amputations of the lower extremities resulting from peripheral vascular disease. This has been a policy of conservatism in selecting the level of amputation, consistent with good surgical judgment. From another standpoint, the very nature of a Veterans Administration hospital makes it possible for patients with chronic disabling disorders such as peripheral vascular disease to be treated without excessive overconcern for prolonged

hospitalization. In addition, the facilities of a very large department of rehabilitation are available to these amputees for the purpose of preparation, measurement and fitting, and finally instruction in the use of a prosthesis. In some ways then it would seem that under such circumstances the results might be regarded as an indication of the limits of conservative surgery and the extent of rehabilitation attainable. However, other factors are to be considered, particularly that of indigence which is seen more frequently in a Veterans Administration hospital than in private practice, and which is commonly accepted to be a responsible factor for delay in seeking proper medical care. For this reason many of our patients have been admitted and treated with advanced disease present in their extremities and also with serious systemic disease. It is believed that this factor played a certain role in what we believe to be a somewhat elevated over-all operative mortality rate (10.1 per cent). There is an additional factor which is also thought to play a role in the end results and which perhaps is even more difficult to evaluate. It is commonly appreciated that residents in an approved residency training program can frequently be trained to a skill and competency as good if not better than that of the staff that trains them. Nevertheless, we definitely think that amputation of the lower extremity for peripheral vascular disease is a procedure which is not particularly attractive to the budding surgeon. As a result this procedure is frequenly assigned to a junior member of the residency staff whose interest in this subject and whose knowledge of the contributions of many authors to this field are probably far from adequate.

In reviewing our material it is apparent that in contrast to the practice of a decade ago, there is a definite tendency to attempt conservative amputations. In our series of 129 amputations, fifty-nine were performed below the knee. These fifty-nine attempts at conservative procedures were attended by twenty-two failures. This fairly large number of failures, however, resulted in only three deaths, a mortality rate of 5.1 per cent. The remaining nineteen patients all underwent successful amputation at a higher level with the exception of one patient who signed himself out against medical advice. It is believed that under the circumstances this operative mortality rate of 5.1 per cent is both acceptable and encouraging in our attempts to do further conservative surgery. A closer inspection of certain sites below the knee and the results obtained with amputations at those sites make one question the advisability of continuing with transmetatarsal and Syme's amputations. Toe amputations also had a high failure rate, but the absence of mortality with this procedure coupled with the absence of disability when it is successful, encourages one to continue with attempts at this level.

Our success in fitting these elderly amputees with a prosthesis has been a source of considerable satisfaction. It appears established that in those patients who have had unilateral amputation of a lower extremity for peripheral vascular disease and who have not yet exceeded man's three score and ten, only definite and serious physical disability need prove a barrier to fitting with a prosthesis and successful instruction in its use. It is also apparent that patients in this age group with its attendant disabilities can frequently be fitted with and instructed in the use of bilateral prostheses.

Moreover, our statistics, we believe, also demonstrate that the elderly lower extremity amputee continues to use his artificial limb for an indefinite period of time afterwards. By our estimate of grading, it appears that patients with amputations below the knee have somewhat better use of their prosthesis than those with amputations above the knee. It is true that the level of proficiency that these elderly amputees attain in the use of their prosthesis falls short of the level attained by the young man who loses his leg because of trauma. Nevertheless, it was most interesting to talk to these patients in their follow-up period and learn that, although some had a walking tolerance of perhaps only one to two blocks (others more), almost to a man they claimed to wear their artificial limb all day because it provided them with the mobility necessary for relatively independent existence.

SUMMARY

1. Our experiences with 129 consecutive amputations of the lower extremities due to peripheral vascular disease in ninety-six patients from February 2, 1953 to June 6, 1558 are tabulated.

2. The predominant cause for these amputations was arteriosclerosis with or without

diabetes mellitus. The presence or absence of the latter condition did not appear materially to affect our results.

3. A very high incidence of serious sytemic disease was noted in these patients. Operative mortality rate was 10.1 per cent. In fifty-nine attempts at conservative surgery, the operative mortality rate was 5.1 per cent, including patients who died following a higher amputation necessitated by failure of the conservative amputation.

4. There was a definite direct relationship between age and mortality and an inverse relationship between age and capacity to be fitted with a prosthesis.

5. Our success in fitting these elderly amputees with a prosthesis was most gratifying, and follow-up study of these patients indicates that the majority were still using their prosthesis and obtaining considerable benefit from its use.

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Arterial Prostheses

A NON-POROUS PLASTIC TUBE AND A DIFFERENT PRINCIPLE OF ANASTOMOSIS

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GREAT advances have been made in replacement of blood vessels with various types of mesh material. The porosity of the mesh is generally believed to be important in the success of these prostheses. Indeed, Egdahl and Hume [1], achieved greater success with vein-lined polyethylene tubes when holes were cut in the polyethylene to allow contact between the vein and surrounding tissues. Others have doubted the necessity for this porosity. Knox and Begg [2] found no vascularization of the interstices of Dacron® grafts which had functioned as arterial conduits for periods of time up to twelve months. Schumaker, Harris, and Sidney [3] have previously reported successful experiments in which the pores of nylon mesh were sealed with polyethylene sheeting and liquid vinyl plastic to make them impermeable.

Replacement of blood vessels with non-porous and rigid or semi-rigid materials has previously been investigated. Materials used have been glass [4], aluminum and gold plate [5], paraffined silver tubes [6], vitallium [7], polished methyl methacrylate [8], siliconized rubber [9,10] and polyethylene [11]. In addition to methyl methacrylate, Hufnagel has mentioned using polyethylene, Teflon,® Kel-F,® nylon, stainless steel, vitallium and other metals [12]. In general, with the exception of methyl methacrylate, thrombosis in the lumen of prosthetic material has resulted in failure.

The inherent simplicity and speed of replacement of blood vessels with a non-porous semi-rigid prosthesis has encouraged us to reinvestigate this problem.

PROCEDURE

Twelve adult mongrel dogs weighing between 7 and 17 kg. were anesthetized with 5.5 mg./kg. of intravenous Nembutal® and connected by an intratracheal tube to a mechanical respirator. With aseptic technic, the chest was entered through the left fifth or sixth interspace and three or four pairs of intercostal vessels were ligated and divided. The aorta was transected between vascular clamps and allowed to retract. A plastic prosthesis* beveled at both ends, with an internal diameter of 6.5 mm. and an external diameter of 8.5 mm. and approximately 5 cm. long was inserted between the two ends of the aorta and secured by the following technique: a No. 4-0 atraumatic silk suture on a cutting needle was passed through the vessel, then the prosthesis, and again through the vessel. Traction on the two ends helped pull the prosthesis into the vessel. The ends were then ligated, passed around the vessel and again ligated. A second circumferential ligature of No. 2-0 cotton was placed

* Flexible Vinyl ES 501, Plastron Specialties, Inc., 286 Ceres Ave., Los Angeles 21, California.

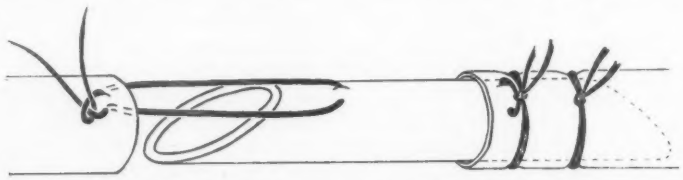

FIG. 1. Diagram showing technic of insertion of plastic tubing into aorta.

several millimeters proximal to this suture ligature. (Fig. 1.) The vascular clamps were removed and the chest was closed without drainage while the lungs were expanded. Surgeons' knots were used throughout, and great care was taken to approximate the vessel to the prosthesis with minimal pressure. This prevented the ligatures from cutting through the vessel, and allowed blood to clot between the two ligatures, so there was minimal leakage.

RESULTS

The occlusion time varied between seven and a half to twelve minutes, the average being ten minutes. Table 1 summarizes the experimental results. Eleven animals survived the initial postoperative period. One animal died due to rupture of the anastomosis, and four animals survived and were in good health when killed from 158 to 226 days postoperatively. Aortograms performed at the time of death correlated well with findings in other animals. These showed the longer the survival of the animal, the greater the occlusion from clot formation at the proximal anastomosis. The prosthesis was soon surrounded by a thin fibrous sheath, and since there was little or no leakage, the large periprosthetic organized clot seen with mesh prostheses was not present.

TABLE 1
RESULTS OF PLASTIC SEMI-RIGID THORACIC AORTA PROSTHESES IN TWELVE DOGS

Date of Operation	Occlusion Time (minutes)	Number of Days to Death or Killing	Result
2-12-58	11	54	Dog incinerated prior to autopsy
2-19-58	12	15	Cause of death undetermined; no clot
2-21-58	10	226	Sacrificed and aortogram performed
2-26-58	8	221	Sacrificed and aortogram performed
2-26-58	7½	38	Clot at proximal end
3-12-58	10	159	Clot at proximal end
3-19-58	9½	155	Clot at proximal end
3-19-58	10	43	Cause of death undetermined; no clot
3-26-58	10½	193	Sacrificed and aortogram performed
3-26-58	12	3	Rupture of anastomosis
4-30-58	10	56	Cause of death undetermined; no clot or leak
4-30-58	9	158	Sacrificed and aortogram performed

COMMENTS

Most solid tubing prostheses have been secured in the host vessel by circumferential pressure which has been applied in general by encircling ligatures of various materials, or by the nylon "multiple point fixation" ring of Hufnagel [*13*]. In the present experiments, the single suture through both the vessel and the prosthesis prevented the vessel from slipping off the prosthesis. We believe that the double ligature, barely approximating the vessel wall to the prosthesis, was important in the survival of that portion of the vessel and in forming a water-tight seal by a blood clot between the two ligatures. The fact that only one animal died of rupture of the anastomosis *per se*, indicates that this method was satisfactory.

While this experiment was designed primarily to test the anastomosis, and the plastic tube was chosen at random, it was interesting that 33 per cent of the grafts remained patent until the animals were killed. Dale and Niguidula [*12*] found only 3 per cent of the grafts clearly defined as less than 8 mm. in diameter and used peripherally remained open. In these animals all the grafts had an internal diameter of 6.5 mm. Failure in this series was due primarily to clot formation at the thick proximal edge of the prosthesis. Hufnagel [*13*] stressed the desirability of a thin presenting edge, and Edwards [*14*] believed thrombosis to be due to insecure attachment of the lining membrane to the wall of the tube.

The speed and technical ease with which such an anastomosis can be performed is a most attractive feature. As temporary conduits for the arterial blood, it can be successfully accomplished by those not especially trained in vascular technics, and might find clinical application in emergency situations and mass casualties. Work is continuing with refinements of this technic in permanent replacement of small blood vessels.

SUMMARY

A method is described wherein replacement of blood vessels with non-porous semi-rigid plastic tubing is accomplished, using a double encircling ligature. To secure the graft, the central ligature is passed through both the host vessel and the graft.

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Autotransplantation of the Spleen Following Traumatic Rupture

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THE term "splenosis" refers to autotransplantation of splenic tissue and was first introduced by Buchbinder and Lipkoff [1] in 1939. They were the first to describe a case of splenosis in this country.

Albrecht [2] in 1896 reported that at autopsy of a twenty-five year old subject with nephritis, approximately 400 small splenic nodules were found scattered over the peritoneum from both diaphragms to the pouch of Douglas. Schilling [3] in 1907 reported similar accessory splenic tissue on the greater omentum, serosal surface of the gallbladder and descending colon. Neither Albrecht nor Schilling reported trauma in their subjects and considered their cases examples of accessory spleens. However, the principal spleen in each case was smaller than normal, scarred, distorted in shape and adherent to surrounding structures. At the present time, the highly multiple splenules are not considered in the same category as the usual accessory spleen.

Von Kuttner [4] in 1910, Faltin [5] in 1911, von Steubenrauch [6] in 1912, Lee [7] in 1923, Kupperman [8] in 1936, Shaw and Shafi [9] in 1937, Jarcho and Andersen [10] in 1939 and Hamrick and Bush [11] in 1942 reported similar instances of patients with numerous small accessory spleens scattered throughout the peritoneal lining. These had all developed subsequent to splenectomy for traumatic rupture of the spleen. These small nodules in most instances contained the characteristic splenic pulp, but the supporting framework seen in the normal spleen was often incomplete. In some nodules the histologic structure was often normal. Buchbinder and Lipkoff [1] pointed out the similar sequence of events in all of these patients, namely, traumatic rupture of the spleen treated with splenectomy, and, after a variable lapse of time, subsequent inspection of the peritoneum either at operation or necropsy revealing numerous small splenotic nodules in unusual locations.

Splenosis resulting from the autotransplantation of splenic tissue was opposed by von Steubenrauch [6,12] and Curtis [14] who adhered to the "splenoid" theory in vogue at that time. Von Steubenrauch believed that loss of splenic tissue can be compensated in the following several ways: by cellular changes in bone marrow and lymph nodes, as well as in pre-existing hemolymph nodes; by regeneration of the main mass of splenic tissue when incompletely removed or by hypertrophy of true accessory spleens; or by formation within the peritoneum of organs having a structure similar to that of splenic tissue which he named "splenoids." These splenoids were supposed to form as a sort of replacement for the absent spleen. However, Kreuter [13] demonstrated that in rhesus monkeys total splenectomy did not result in any such compensatory formations. Embryologically, the spleen develops from anlagen in specific areas of the celomic epithelium (left side of the dorsal mesogastrium). Von Steubenrauch carried his idea further by presuming that under exceptional circumstances epithelial anlagen might occur in a number of other foci, thereby giving rise to any number of splenic nodules. Curtis and Movitz [14] demonstrate convincingly the improbability of the splenoid theory. Their most significant argument is that splenosis has not been described following splenectomy for nontraumatic disease of the spleen except in one questionable instance [15]. Thus, not removal of the spleen but rather trauma resulting in

seeding of the peritoneum with small splenic fragments appears to be the important factor in producing splenosis.

Experimental autotransplantation of splenic tissue is another point in favor of trauma in causing splenosis. Even von Steubenrauch [6] successfully implanted autogenous splenic fragments in many experimental animals. Kreuter [13] excised the mammalian spleen and smeared its pulp over the peritoneal surfaces. Later, he found widely scattered nodules resembling splenic tissue. Putschar [16] went further in placing autogenous splenic implants in subcutaneous tissue in addition to those on the peritoneum. All but two of Putschar's transplants developed into splenic nodules, even those developing within the subcutaneous tissue remote from celomic epithelium. Roettig, Nusbaum and Curtis [17] successfully implanted splenic tissue on the peritoneum in the rabbit. They observed that splenotic nodules became grossly visible in the rabbit not earlier than six months following the seeding of the peritoneal surfaces. Kupperman's report [8] of a fifteen year old boy and the present report of a nine year old girl in whom splenosis developed within six months after an emergency splenectomy for traumatic rupture indicate that transplanted splenic tissue can grow more rapidly in man than in the rabbit.

Garamella and Hay [24] succeeded in experimentally transplanting splenic tissue in the pericardial sac of dogs under one year of age. They were interested in the possible production of increased blood supply to the myocardium via vascular splenic implants.

Shaw and Shafi [9] found a nodule in the left pleural cavity of their patient at the level of the eighth dorsal vertebra, and another just inside the capsule of the left lobe of the liver. It was difficult to explain the locations of these nodules except to assume the presence of an unrecognized rent in the diaphragm or a tear in the liver surface which had healed without leaving a visible scar.

While autotransplantation of the spleen following traumatic rupture occurs most commonly in younger people, cases in adults have been reported by Waugh [18] and Wise [19].

Cotlar and Cerise [20] recently presented two cases of splenosis, one of which they believe is the first case of intestinal obstruction directly due to a solitary splenic transplant.

Skinner and Hurteau [21] in 1957 reported on a patient with intrathoracic splenosis involving the parietal and visceral pleura and lung. The diagnosis was made at operation ten years after a shrapnel wound which resulted in rupture of the diaphragm and spleen.

The present-day accepted concept of the mechanism of autotransplantation of the ruptured spleen is as follows:

1. Autotransplantation of splenic tissue occurs only in young patients who have suffered traumatic rupture of the normal spleen. Hamrick and Bush [11] believe that the likelihood of success in grafting cells from splenic pulp on peritoneal surfaces is proportionate to the youthfulness of the normal spleen.

2. The seeding of splenic pulp cells on peritoneal surfaces is accomplished through the medium of the free blood present in the abdominal cavity following splenic rupture. After implantation, the nests of cells grow, and the nodules finally become encapsulated by fibrous tissue. On maturity, these splenic implants are found to have histologic structure not unlike that of a normal spleen.

CASE REPORT

D. S., an eight year old girl, was referred to the Northern Westchester Hospital on July 29, 1958, by Dr. John Simmons of Brewster, New York. Two hours prior to admission, the patient had fallen from a wall 8 feet high, and shortly thereafter had complained of pain in the left flank. Physical examination revealed a pale and acutely ill young girl. Blood pressure was 100/60 mm. Hg and pulse 84 per minute. There was a contusion over the seventh to ninth ribs in the mid-axillary line on the left side of the thorax, with tenderness to pressure in this area. The entire upper abdomen was tender and there was spasm of the musculature of the left upper quadrant. The liver and spleen were not palpable. Laboratory findings revealed a hemoglobin of 10.6 gm. per cent and a white blood count of 24,500 per cu. mm. with 74 mature polymorphonuclear leukocytes, 9 band neutrophils, 16 lymphocytes and 1 eosinophil. Hematocrit was 37 per cent.

Roentgenographic examination of the chest, left ribs and abdomen revealed no abnormalities. Abdominal paracentesis was performed in the left upper quadrant and a small amount of bloody fluid was obtained. A diagnosis of rupture of the spleen was made and exploratory laparotomy was performed on the day of admission. The spleen was found transected completely across its upper pole. Splenectomy was performed and the patient was discharged from the hospital on the seventh postoperative day after an uneventful course.

FIG. 1. Three nodules with the general histologic characteristics of spleen found in the greater omentum.

FIG. 2. Splenic tissue from the serosa of the jejunum. Note malpighian corpuscle with eccentric arteriole.

Five months later, on December 27, 1958, the patient was readmitted to the hospital because of periumbilical pain and persistent vomiting. Physical examination revealed an acutely ill young girl vomiting clear stomach contents and writhing uncontrollably. There was bilateral lower abdominal tenderness to pressure without mass or spasm. Rectal examination revealed no abnormalities. Hemoglobin was 11.7 gm. per cent and the white blood count was 10,200 per cu. mm. without a shift to the left. The pain continued and later that day was localized to the right lower abdominal quadrant and the white blood count rose to 18,700 per cu. mm. Roentgenographic examination of the abdomen showed no abnormalities. Operation was performed on the evening of admission and preoperative diagnosis was acute appendicitis with the suggestion that splenosis could be the cause of the patient's difficulties. The abdomen was found to contain bloody fluid and the appendix was normal. Exploration of the pelvis revealed reddish pink tissue implants in the cul-de-sac and the posterior wall of the uterus reminiscent of endometriosis. However, splenosis was immediately considered as the best likely explanation. Exploration of the proximal intestine revealed a thick fibrous band obstructing the proximal jejunum. Lysis of this band corrected the obstruction. Small pink nodules 2 mm. in size were seen on the greater omentum and several similar nodules were present on the serosa of the ileum. These were removed for examination by the pathologist. The procedure was concluded with appendectomy. The postoperative course was uneventful except for a superficial wound infection. The report of the pathologist was as follows: the specimen consists of reddish grey nodules up to 0.6 cm. in widest diameter, partially surrounded by lobules of adipose tissue. The nodules are soft and appear to be encapsulated. The cut surfaces are dark red streaked with grey.

Microscopically, all the nodules have the general cytoarchitecture of the spleen. (Fig. 1.) They are composed of red and white pulp interspersed with a few malpighian corpuscles. At the periphery there is a thin connective tissue capsule from which scattered delicate trabeculae radiate centrally. (Fig. 2.)

COMMENTS

To our knowledge, this is the first case of splenosis in which the diagnosis was correctly suggested preoperatively. This, however, was the result of a high index of suspicion occasioned only by the fact that the surgeon him-

self had performed the splenectomy only five months previously. Indeed, splenosis has no characteristic clinical picture and it is generally denied that splenosis produces signs and symptoms. However, a few exceptions can be mentioned. Gill's patient [22] had a subcutaneous splenic transplant which enlarged and became tender in response to a malarial attack. Stobie's patient [23] may have had a recurrence of congenital hemolytic icterus due to splenosis. Already mentioned is the patient of Cotlar and Cerise [20] whose episode of intestinal obstruction was due directly to a solitary splenic nodule which formed the base of an obstructing band. In most instances, splenosis is accidentally discovered at laparotomy for instestinal obstruction secondary to non-specific bands, acute appendicitis and exploratory laparotomy and routine autopsy.

PATHOLOGY

At the operating table splenic implantation occurs on the small intestines, omentum, parietal peritoneum, large intestines and mesentery of the bowel in that order of frequency. The pleura, diaphragm, lungs, liver, stomach, gallbladder, appendix, kidneys, ureters, uterus, ribs, urinary bladder and fallopian tubes have also been involved. The nodules are from 1 mm. to 2 cm. in size, vary in color from tan to dark red and are unassociated with any surrounding inflammation on the parastized organ; splenosis can be mistaken for endometriosis, metastatic carcinoma or hemangioma.

Microscopically, the implant may have all the constituents of a normal spleen or only the red pulp to identify the tissue as splenic in origin. Cotlar and Cerise [20], in their excellent review, provide a comparison of autotransplants and true accessory spleens as follows:

1. The history of trauma is absent in accessory spleens.

2. The location of accessory spleens is determined by embryologic development from the left side of the dorsal mesogastrium so that only the following regions are involved: the hilar region of the spleen, the splenic pedicle, retroperitoneal region surrounding the tail of the pancreas, the great omentum especially along its attachment to the greater curvature of the stomach, the splenocolic ligamentary attachments, the mesentery of both large and small intestines, and, in women, the left adnexa, and, in men, in the scrotum attached to the tunica albuginea of the left testis. On the other hand, implants are even more widespread so as to include the remainder of the peritoneal cavity, lung, rib and subcutaneous tissue.

3. Accessory spleens are only one or two in number while implants are quite numerous so that as many as 100 have been counted in one patient.

4. Accessory spleens are larger than transplants: 2 to 5 cm. vs. 1 mm. to 2 cm.

5. Accessory spleens have a pedicle and hilum; transplants do not.

6. The blood supply of an accessory spleen enters at the hilum, while the vessels of a transplant enter the capsule at the periphery.

7. The capsule of an accessory spleen contains a normal amount of smooth muscle and elastic tissue. The capsule of a splenic implant is thick and fibrous with a decrease in smooth muscle and elastic tissue.

8. The red pulp is normal in an accessory spleen. The red pulp of a splenic transplant may be normal or in various stages of degeneration, often with increased amounts of hemosiderin.

9. The malpighian corpuscles and trabeculae are normal in the accessory spleen. In the transplant, the malpighian corpuscles may be decreased in development and number with absence of the small central artery. The trabeculae of the implant are normal or decreased in number.

10. The function of the accessory spleen is the same as that of the principal spleen. There is evidence that well developed transplants possess some of the functions of normal splenic tissue.

SUMMARY

1. A case of autotransplantation of the ruptured spleen in which the diagnosis was suggested preoperatively is presented.

2. The historic background of this rare condition is presented.

3. The pathologic and clinical pictures are discussed.

4. The differential diagnosis between accessary spleens and splenic implants is considered.

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The Problem of Traumatic Spondylolysis

A REPORT OF THREE CASES

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MANY patients with spondylolysis attribute onset of symptoms to an injury. Very few of these, however, are regarded as having sustained actual fracture of the pars interarticularis at the moment of trauma, and still fewer have available roentgenograms to prove the existence of an intact neural arch prior to the accident. Thus in the majority of such instances symptoms are attributed to aggravation of a pre-existing and supposedly congenital condition.

In spite of a considerable body of information to the contrary, it is apparent from a preview of recent literature that most writers still regard spondylolysis as congenital in origin. Increasing numbers of case reports, however, support the contention that the typical isthmal defects can occur after injury. Indeed, during a critical review of the voluminous writings of the past 100 years we have been unable to find reports of a single case of bona fide congenital spondylolysis.

Our purpose is to present a brief commentary on the literature dealing with the etiology of spondylolisthesis and spondylolysis and to present three cases in which trauma was the proved cause.

HISTORICAL NOTE

Credit for the first recognition of spondylolisthesis is usually given to Kilian [*10*] who, in 1854, described four such specimens. According to Roasenda [*22*], Kiwisch and Seifert of Prague preceded him by three years. In 1855, Robert [*23*] of Coblenz established, as the fundamental lesion of spondylolisthesis, the break in the neural arch and demonstrated forward dislocation of the body of the last lumbar vertebra after its neural arch had been cut through and a force equivalent to its usual weight-bearing load had been applied. He also showed that when all the ligaments connecting the last lumbar vertebra to the sacrum are cut, no displacement occurs providing the neural arch is intact.

The Theory of Congenital Origin. Schwegel [*24*] (1859), and Rambaud and Renault [*21*] (1864) were the first to describe two ossification centers in each side of the neural arch, *an erroneous observation* which led the latter authors to postulate failure of union of the two anlagen as the cause of spondylolysis—a view prevalent even today. Neugebauer's [*20*] classic thesis of 1884 supported the congenital theory of origin, although he laid more stress on trauma as the causative factor. Also supporting the congenital theory were publications by Schmorl [*27*], Junghanns [*9*], Friberg [*5*], Brocher [*2*], and Turner and Tchirkin [*34*]. Modifying this point of view but still adhering to the theory of congenital origin was Willis [*37*] who, in 1931, stated that ossification of the neural arches depends on two lateral centers, only one for each side. He indicated, however, that each lateral center occasionally splits into an anterior half which produces the pedicle and the upper articular process, and a posterior half which produces the remainder of the neural arch. Willis thought that the split ossification centers of one neural arch may fail to fuse, so that a pseudarthrosis is formed between the pedicle and the major part of the lamina. No one since Willis' publication has been able to confirm the presence of two ossification centers for each half of the arch, either as original anlage or as a split or divided center.

Chandler [*3*], in his study of fetal spinal columns cut in serial sections to show the isthmus (pars interarticularis) of the lamina,

found no evidence of a divided osteogenetic center. He noted that bone formed first in the interarticular portion and extended gradually in both directions, that is, anteriorly through the pedicle proper to meet the body and posteriorly to meet the lamina of the opposite side. In several sections he observed that ossification progressed by forming cyst-like spaces and suggested that this observation together with "the incomplete fissure occasionally seen at the region of the isthmus in the roentgenogram adds weight to the theory of defective ossification rather than fracture." Mutch and Walmsley [*19*] conducted a similar study in fetuses ranging from 75 to 130 mm. in length in an effort to establish the cause of clefts in the vertebral arch. They concluded that ossification of the arch is not enchondral as in the epiphysis but subperiosteal as in the diaphysis, and that cleavage in the isthmus is not due to non-union of two separate centers but to defective development of bone in the isthmus of the vertebral arch. The fact remains, however, that they did not demonstrate such defects.

By 1934 the notion that all defects of the neural arch were not necessarily congenital was voiced by Kleinberg [*12*] when he admitted that the "genesis of spondylolisthesis is, therefore, in a measure still *sub judice*." At the same time he reported the case of an infant, seventeen months of age, admitted to his hospital for treatment of congenital dislocation of the hip. Routine roentgenographic study of the spinal column revealed forward displacement of the fifth lumbar vertebra on the sacrum associated with bilateral defects in the arch at the pars interarticularis. Because a history of injury could not be obtained, he considered this an example of actual congenital spondylolisthesis.

Also supporting the congenital origin of defects of the pars interarticularis in the recent literature have been King and associates [*11*], Friberg [*5*], George [*6*], and Wiltse [*38*] who have based their arguments on the predilection of certain families toward the development of such defects. Wiltse surveyed twenty-four families and found defects of the arch in 31.3 per cent as compared to an incidence of about 5 per cent in the general population. He concluded that the break in the pars was due to a congenital weakness at this point.

The Theory of Acquired Origin. Lane [*14*], in 1893, and later Meyer-Burgdorff [*18*] suggested that spondylolisthesis is always acquired. They expressed the view that constant pressure of the articular processes above and below the affected vertebra could produce a zone of rarefaction (Umbauzonen) in the interarticular portion of the lamina. Jaeger [*8*] proposed somewhat the same view in stating that avascular necrosis of the pars interarticularis was the basis for the break in bony continuity. The possibility that the defect is the result of chronic strain and subsequent stress fracture has been mentioned by Roberts [*24*], Meyer [*17*], and Thieme [*33*].

Fracture of the pars interarticularis through direct trauma, either by hyperflexion or hyperextension injuries, has been demonstrated a number of times, although according to Unander-Scharin [*35*] early experiments by Robert, Königstein, Gerlach, Turner, and Markello on cadavers failed to produce spondylolysis even though considerable force was used. Hitchcock [*7*], on the other hand, hyperflexed the spinal columns of stillborn children varying in age from eight months gestation to term and infant cadavers up to ten months of postnatal development and stated that "with little force" he was able to fracture the neural arch low in the lumbar region. Such fractures were usually bilateral, but unilateral fracture could be produced by combining flexion with lateral bending and some torsion. His efforts at hyperextension failed to produce fractures in the lamina. Rowe and Roche [*26*] were unable to repeat these experiments in several infant cadavers but pointed out that the conditions pertaining to a cadaver are quite different from those in a living infant.

By far the most convincing evidence in favor of acquired defects is the scholarly work of Rowe and Roche who summarized the investigations of Botts, Chandler, Friberg, Hitchcock, Mall, Noback and Sensenig in a table listing the number of fetal and neonatal skeletons studied for their bony development. In a total number of 509 specimens including 73 of their own, no defects in the neural arch could be found nor did any show two centers for one side of an arch.

In addition to fetal columns these authors [*26*] studied 4,200 adult skeletons from the Terry Collection of Washington University and the Todd Collection of Western Reserve. Added to this is a roentgenographic survey of

140 children and a summary of the roentgenologic findings in 13,786 individuals of all ages. Among this material they found a complete absence of the defect at birth, a higher incidence in children and a still greater incidence in adults. They concluded that, since no proof exists to support a congenital origin, "it appears, therefore, that the lesion is an acquired one, but the manner in which it is acquired is not yet understood."

Of comparable significance are the researches of Stewart [32] using 786 skeletons of Alaskan natives. After this study, Stewart accepted the view that each half of the arch is usually intact at birth whereas it is often defective in the adult. He reasoned that, if the defect was not congenital, the incidence would increase at a regular rate during life. The age incidence of arch defects in the 786 Alaskan skeletons was 5 per cent of those at six years of age, 17 per cent at thirty years of age and 34 per cent in the group thirty to forty years old, with no increase in incidence after the age of forty—a striking example of increasing age incidence.

In his earlier publication Stewart had assumed that spondylolysis was congenital but in this one he stated, "The new evidence of progression in incidence from about zero at birth makes this explanation untenable." He considered that defects through the pedicles were fractures, mainly because of the callus formation present, and the lack of evidence of associated fractures in other bones. He found, however, a coexisting interarticular defect on the opposite side. He said, "It may be assumed, therefore, either that the interarticular defect was caused at the same time as the pedicle fracture or that it preceded and predisposed to this fracture. Since the pedicle is stout bone, it is difficult to account for its fracture except through a direct blow, perhaps with previous weakening of the arch at another point. If this is so then fractures of both isthmi due to injury should be even more common than pedicle fractures."

Stewart suggested that chronic strain produced by flexion of the spine with the legs straight, the position assumed in cleaning seal skins or riding in a kayak, or frequent falls on ice probably account for the high incidence in the Eskimo.

CASES REPORTED IN THE LITERATURE

Without doubt, many individuals with spondylolysis are free of symptoms until injury stretches the ligaments that support the loose segment. On the other hand, there are patients who have fractures of the neural arch and whose roentgenographic findings are indistinguishable from those in cases previously regarded as congenital in origin. Also, in several instances a defect of the pars interarticularis has appeared in the most cephalad segment of the several included in a surgical fusion. In these instances, the break in continuity may be supposed to have occurred in the arch because the bone here was smaller or weaker than the bony mass of the posterior fusion. Whether the fracture of the lamina occurs as the result of repeated stress or from a single injury is sometimes difficult to determine. Several examples of traumatic spondylolysis will be cited.

Reference has been made to Hitchcock's experiments with infant cadavers. By acutely flexing the spinal columns, he was able to produce fracture of the isthmus of the lamina. Although acute flexion appears to be the usual mechanism of injury in patients with such fractures, Watson-Jones [36] described an acrobatic dancer who "went onto the stage without the usual fifteen or twenty minutes of loosening or limbering. In the course of her dance when, with her spine fully hyperextended and her head between her legs, there was an ominous crack; she suffered agonizing pain, having sustained a fracture of the neural arch of the first lumbar vertebra."

Roche [25] reported the case history of a twenty-two year old man who was injured when a jeep in which he was riding was overturned. The man sustained multiple injuries including a dislocation of the left shoulder, fracture of the left scapula, left transverse processes of the fourth and fifth lumbar vertebra and fractures of both sides of the pelvis including the ischial and pubic rami. He also sustained bilateral fractures of the pars interarticularis of the third lumbar vertebra. The patient remained on a Stryker frame for four months at which time the roentgenogram revealed new bone formation with healing.

Metgé [16] reported the case of a forty year old coal miner who sustained multiple injuries in an accident which occurred in 1946. Roentgenographic examination of the spinal column, however, was entirely normal. When seen again in 1952 he was complaining of backache, and roentgenograms of the spinal column revealed bilateral isthmal defects and spondylolisthesis

of the fifth lumbar vertebra on the first sacral vertebra.

Marique [*15*] presented four cases of spondylolysis with spondylolisthesis, one without spondylolisthesis and four with fractures of the articular processes and spondylolisthesis. He favored trauma as the cause of spondylolysis. Sicard and Leca [*31*] reported isthmal fractures in two children with subsequent displacement. They also stressed the importance of trauma as the etiologic factor in spondylolysis.

Serre's [*30*] patient was a seventeen year old boy first seen because of mild backache. Roentgenographic examination including oblique views revealed no evidence of arch defect. When seen again five and a half years later, after duty with a company of parachutists, he complained of severe back pain which he attributed to a jump. A roentgenogram revealed spondylolysis on the right.

Schneider and Melamed [*28*] reported the case of a boy examined first at age four and a half years when he was hospitalized for whooping cough. His parents stated that at one year of age he had fallen down stairs but had apparently sustained no injury. A roentgenogram made six months after the episode of whooping cough disclosed no evidence of spondylolysis; however, the intervertebral space between the third and fourth lumbar vertebra was narrowed and the diagnosis of interspace infection was made. At the age of five years and four months the roentgenographic picture was unchanged. At age eight and a half years, however, narrowing of the third lumbar interspace and spondylolisthesis at the lumbosacral junction were evident. Roentgenograms made again at the age of fifteen revealed a wider gap at the defect in the isthmus, increased displacement of the fifth lumbar segment with thinning of the disk, and almost complete obliteration of the third lumbar interspace. Eventually, spinal fusion was required and symptoms were relieved.

Kleinberg and Burman [*13*] have reported on traumatic spondylolisthesis in three adults; the vertebra which became displaced was not the one with the laminar defect, but the one below it. Their explanation of this rare pathologic state was that the body of one vertebra was so thoroughly bound to the one above it that "the injury which either caused the laminar defect by fracture or aggravated a previously existing congenital defect by stretching the fibrous tissue, bridging the laminar defect, precipitated the forward slipping" of the lowest segment.

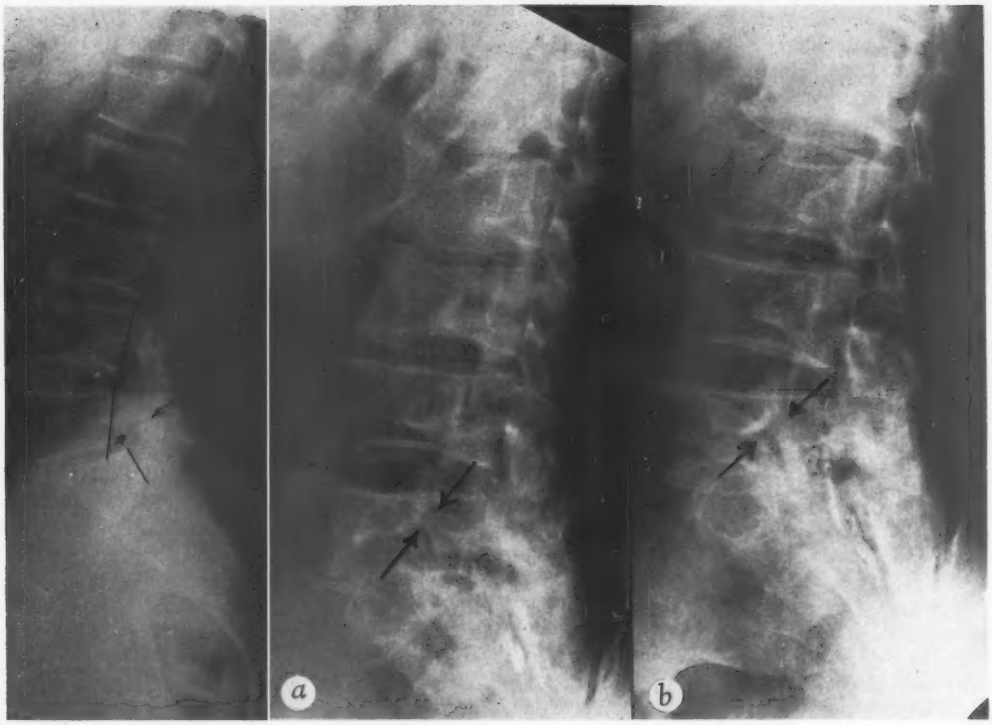
Anderson [*1*] has published an interesting account of spondylolysis appearing after surgical fusion. The patient, a thirty-six year old housewife, was examined because of low back pain in April, 1949, at which time the roentgenogram disclosed no evidence of neural arch defect. On September 26, 1949, a herniated disk was removed from the lumbosacral interspace and the fifth lumbar vertebra was fused to the sacrum. In March, 1952, thirty months after the fusion, the patient noted midlumbar ache and pain in the right hip and leg. A few days later she bent forward to lift her youngest child from the floor and experienced severe pain in the lumbosacral region and right buttock. A roentgenogram made on April 11, 1952, revealed solid fusion of the lumbosacral joint, but there was a defect at the isthmus on the right. Symptoms gradually subsided with rest in bed and a brace. The pain recurred in a few weeks and on May 4, 1952, the roentgenogram revealed bilateral defects in the isthmic portions of the fourth lumbar vertebra. Symptoms gradually subsided, but when she was last examined in October 1954, the defects had not healed. That healing can occur is attested to by Dommisse [*4*] who reported on three patients whose neural arch defects healed after an interbdoy fusion.

Unander-Scharin has reported a similar case in which bilateral defects of the third lumbar vertebral arch developed in a forty-five year old woman five years after fusion of the third, fourth and fifth lumbar vertebrae to the sacrum. Roentgenograms made on three previous occasions had disclosed no evidence of neural arch defect.

In each of these patients, added strain at the pars interarticularis was probably responsible for fracture. Whether separation of the pars occurred with a single injury or through gradual strain and stress is difficult to surmise. It is interesting to note, however, that in Anderson's patient, separation developed on the left, at the same level, three weeks after fracture of the fourth lumbar vertebral arch on the right.

CASE REPORTS

CASE 1. A forty-three year old, retired prize fighter registered at the Mayo Clinic on May 25, 1955, with a complaint of chronic backache which he attributed to a strain while lifting in 1942.



1 2

FIG. 1. Case 1. Spondylolisthesis, grade 1, of the fifth lumbar vertebra on the sacrum. The defect of the neural arch is indicated by arrows. Note the intact arch of the fourth lumbar vertebra.

FIG. 2. Case 1. Three months after fusion of the fourth lumbar vertebra to the sacrum. A, right and B, left oblique views. Note neural arch defects (between arrows) at fifth lumbar vertebra. The neural arch of the fourth lumbar vertebra is still intact.

Since that time, he had suffered from severe episodes of pain once or twice a year, each of which had lasted two or three days. Pain referred to the right buttock and thigh as far down as the knee was associated with pain in the lower lumbar region.

In February, 1955, he was struck across the lumbar region by the trunk lid of a car while leaning into the trunk. After this injury, symptoms became more severe.

Physical examination revealed limited motion of the lumbar portion of the spinal column and tenderness in the region of the lumbosacral joint. Roentgenographic examination on May 25, 1955 disclosed spondylolisthesis, grade 1, of the fifth lumbar vertebra on the sacrum with bilateral defects in the neural arch. (Fig. 1.) There was no neurologic deficit and a myelogram made after administration of iophendylate (Pantopaque®) on July 6, 1955, was interpreted as being within normal limits. On July 11, 1955, fusion of the fourth and fifth lumbar segments to the sacrum was performed using donor bone from the posterior crest of the left ilium. The postoperative course was uneventful, and the patient was dismissed from the hospital eighteen days after operation. When seen for follow-up examinations on October 26, 1955 (Figs. 2A and B), and in February, 1956, he appeared to be convalescing satisfactorily and had no pain. Roentgenograms revealed a firm fusion.

In December, 1956, the pain gradually returned and persisted. A roentgenogram made on July 24, 1957, was suggestive of a neural arch defect at the fourth lumbar segment. (Fig. 3.) A fabric back support, rest, heat and massage were recommended.

The patient was next seen on December 3, 1957. On November 18, he had been injured in an automobile accident and severe back pain had begun an hour or so after the injury. Pain was severe and persistent, and he was unable to straighten up from a semiflexed positon. Roentgenograms

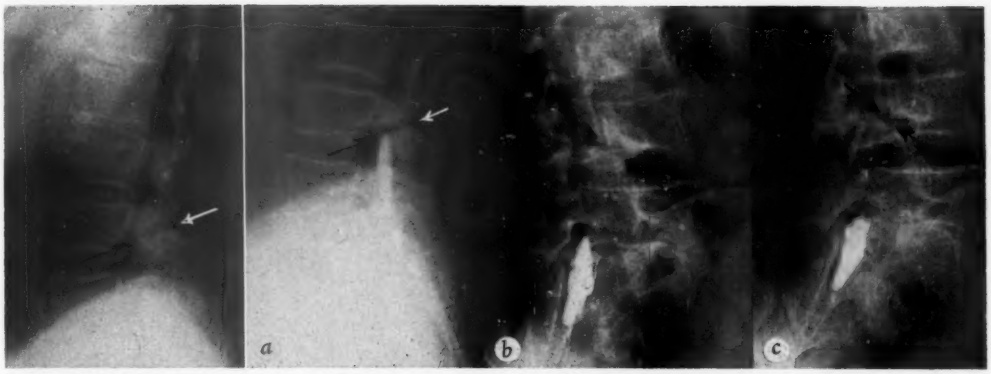


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FIG. 3. Case 1. Sclerosis and early stress fracture of the pars interarticularis at the fourth lumbar vertebra.

FIG. 4. Case 1. Two months after an auto accident; typical so-called congenital defects of the pars interarticularis of fourth vertebra are evident. A, right lateral, B, right oblique, and C, left oblique views.

made on January 22, 1958 revealed bilateral fractures of the pars interarticularis at the fourth lumbar segment. (Figs. 4A, B and C.) Rest and a chair-back type of brace were recommended. Symptoms gradually subsided and by April, 1958, he was able to discard his brace. When last examined on August 12, 1958, he was free of pain and the roentgenogram revealed apparent healing of the neural arch defects. (Fig. 5.)

CASE II. On October 10, 1955, a thirty-six year old nun was brought to the hospital complaining of severe pain in the lower lumbar region following a fall out of an apple tree. Ten years previously on March 10, 1945, she had undergone right hemilaminectomy and exploration for protruded disks at the fourth and fifth lumbar interspaces. Although some improvement of her symptoms was noted, she continued to complain of pain in the back, both thighs and the calves.

On October 3, 1945, a second spinal operation was performed. No evidence of a protruded disk was observed. Spinal fusion of the fourth and fifth lumbar segments to the sacrum was performed, using donor bone from the left tibia. Her pain continued. A pseudarthrosis of the bone graft was suspected and on January 10, 1948, this diagnosis was confirmed at operation, the defect being found between the fourth and fifth lumbar segments. The non-union was repaired with bone taken from the left iliac crest. (Figs. 6A and B.)

Although sound fusion was demonstrated subsequently by roentgenograms made with the spinal column in maximal flexion and extension, the patient continued to complain of pain in the back and legs. Psychotherapy was begun on October 2, 1951.

FIG. 5. Case 1. Defect at the fourth lumbar vertebra appears to be healing and bridged with bone.

The last visit prior to the injury was on August 21, 1954, at which time symptoms had improved and a roentgenogram disclosed no additional information.

A roentgenogram made on October 10, 1955 (Fig. 7), the day of injury, revealed a compression fracture of the body of the fifth lumbar vertebra

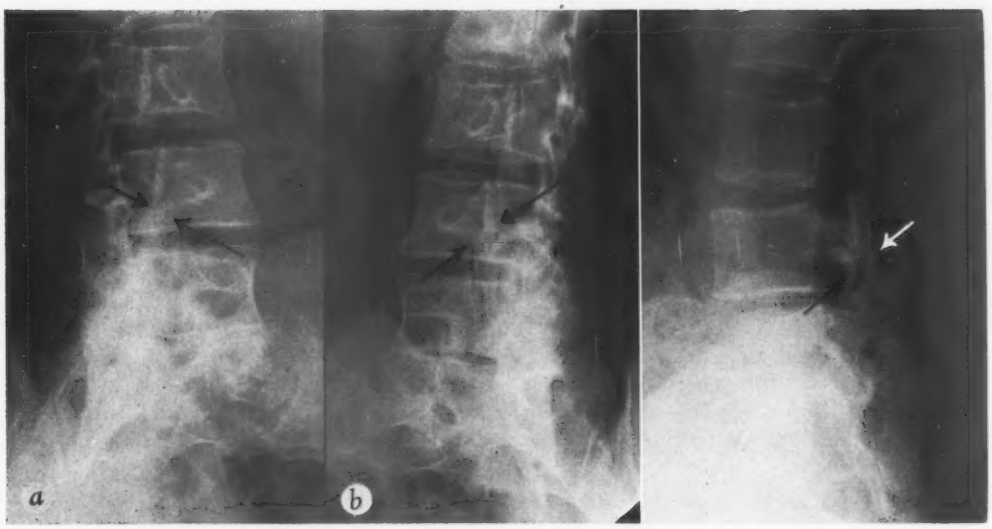

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FIG. 6. Case II. Roentgenograms made on July 7, 1948. A, right, and B, left oblique views showing normal pars interarticularis (arrows) of fourth lumbar vertebra.

FIG. 7. Case II. Lateral view made on day of injury showing compression fracture of body of the fifth lumbar and fracture through the pars interarticularis of the fourth lumbar vertebra.

FIG. 8. Case II. Bilateral defects of the neural arch of the fourth lumbar vertebra are shown. A, right and B, left oblique views.

FIG. 9. Case II. The arch defect on the left is still evident, but appears to be healing. Compare the lateral view with that made on October 10, 1955. (Fig. 7.) The defect on the right appears to have healed.

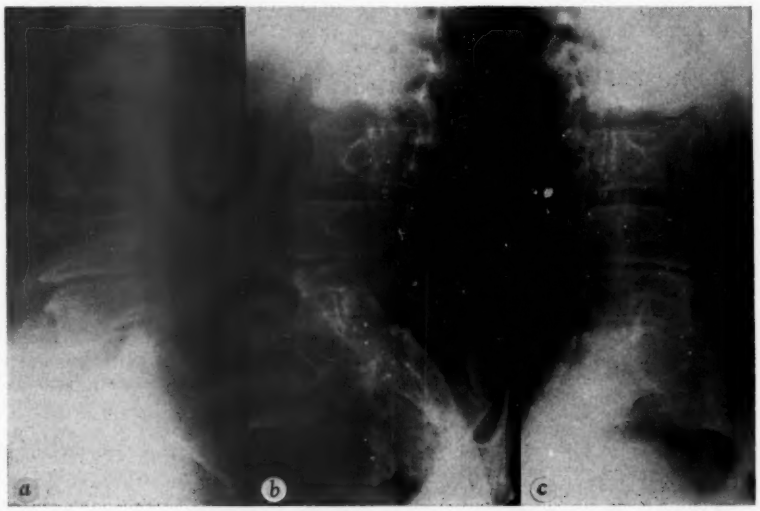

FIG. 10. Case III. Roentgenograms made on May 12, 1955. A, lateral, B, right oblique and C, left oblique views. There is no evidence of a defect in the neural arch in the fourth lumbar vertebra.

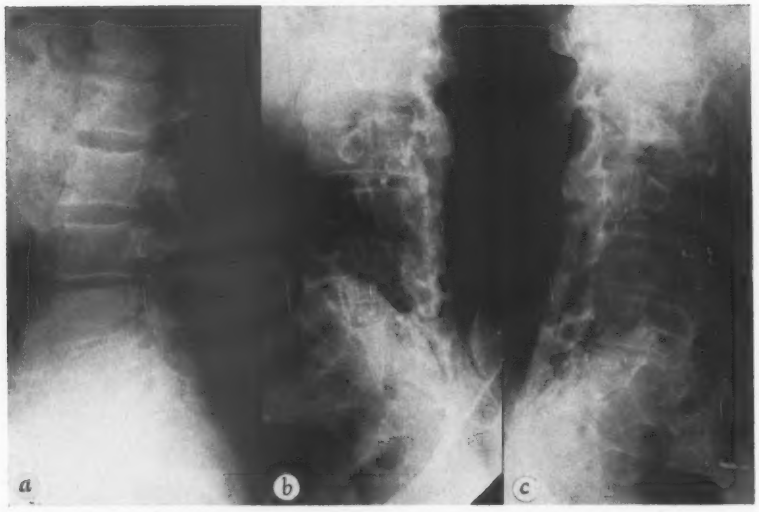

FIG. 11. Case III. Roentgenograms made on July 30, 1957, two years after fusion extending from the second lumbar vertebra to the sacrum. The neural arches appear intact.

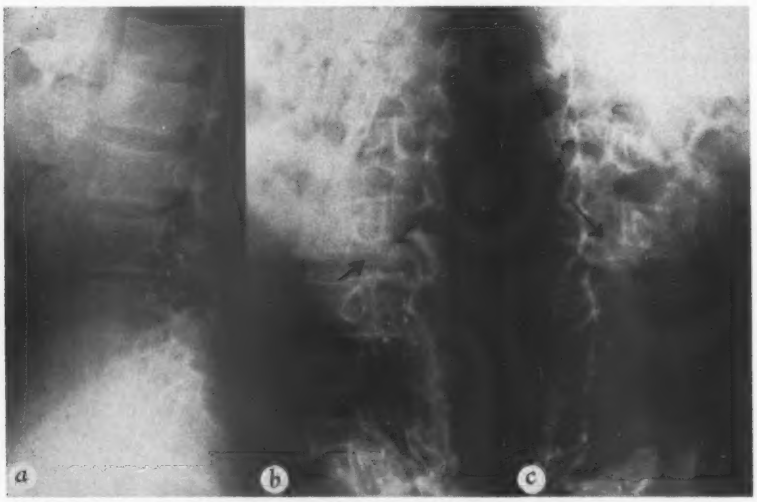

FIG. 12. Case III. Roentgenograms made on January 3, 1959, six months after the onset of symptoms. Note bilateral defects in the arch of the second lumbar vertebra (arrows) at pars interarticularis.

and fractures of the neural arch of the fourth lumbar vertebra through the pars interarticularis on each side. The patient rested on a firm bed for seventeen days before a body cast was applied with the back in hyperextension. The cast was worn until January 3, 1956. Roentgenograms made on that date (Figs. 8A and B) revealed defects still present in the neural arch, although there was some suggestion of healing. She was advised to continue wearing her brace. When she was last examined on March 8, 1956, pain had diminished. The roentgenograms made on that date (Figs. 9A, B and C) revealed the defect on the left, but it appeared to be healing; a defect could not be seen on the right and healing appeared complete on that side.

CASE III. A fifty-five year old electrician was admitted to the hospital on January 2, 1959, be-

cause of severe spasms of pain in the lower lumbar portion of the back. He dated his present episode of pain to June, 1958, at which time the pain had started while he was working in an awkward position on a motor. Pain had been persistent since that time.

His first symptoms referable to the back had followed a fall in 1934. At that time sciatica on the left side had been associated. On November 1, 1938, protruded disks were removed from the third and fourth lumbar interspaces. The patient got along well until he was thrown out of his car in December 1950. The backache then recurred and was not relieved by the usual non-operative measures. On April 23, 1951, a small protrusion of disk material was found at operation at the fourth lumbar space. Again his symptoms were relieved, only to recur in 1953. A myelogram on May 24, 1955, revealed a defect at the level of the third lumbar interspace, and at operation on May 25 a protrusion was found there. (Fig. 10A, B and C.) Exploration of the fourth interspace revealed nothing. At the same operative procedure a fusion was performed from the second lumbar to the third sacral vertebra using donor bone from the left tibia. The postoperative course was complicated by a low-grade fever and an infection at the fourth lumbar interspace. This subsequently subsided, resulting in fusion of the vertebral bodies of the fourth and fifth lumbar vertebrae. (Figs. 11A, B and C.) Symptoms finally subsided, and no further difficulty was encountered until June, 1958. This led to his admission on January 2, 1959.

A roentgenogram of the lumbar vertebrae revealed solid fusion and also a defect of the neural arch of the second lumbar segment. (Figs. 12A, B and C.) This defect had not been apparent on any of the previous roentgenograms. Following application of a plaster body cast on January 13, 1959, symptoms subsided.

SUMMARY

The literature concerning the etiology of spondylolisthesis is reviewed from 1851 to the present. Perusal of this material did not yield a logical reason for considering the defect in the neural arch, which is the precursor of spondylolisthesis, as congenital in origin. The literature concerning traumatic spondylolysis has also been reviewed and reported cases cited. Three additional cases are reported.

From the evidence presented thus far we are forced to conclude that "congenital spondylolysis" is an entity which has yet to be demonstrated, and that its acceptance as an entity is a perpetuation of early, erroneous observation

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Penetrating Injuries to the Chest

CLINICAL RESULTS IN THE MANAGEMENT OF 769 PATIENTS

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BETWEEN the years 1948 and 1958, 769 patients were admitted to Grady Memorial Hospital for treatment of penetrating injuries of the chest. An additional 216 patients were hospitalized during the same period for non-penetrating injuries to the lungs or pleura. The observations recorded on those patients treated for penetrating injuries only are discussed herein. The patients were from two to eighty years of age, and most of them were young adult men.

Many of the observations made heretofore on penetrating thoracic trauma have been made on injuries inflicted in war [3]. It is pertinent, therefore, to record the experiences in a civilian hospital. (Table 1.)

Boland [1], in 1936, reviewed 1,009 patients with penetrating trauma treated at this hospital. Elkin and Cooper [7], in 1943, reported their observations on 1,132 patients treated at the same hospital. Observations are now available on 2,910 patients with penetrating trauma treated at one hospital, covering the years 1922 through 1957, with the exception of the years 1944 to 1947.

Valle [19] reported a mortality of 1.9 per cent among 2,811 patients whom he treated in Japan for penetrating trauma to the chest. The injuries occurred during the Korean battle, and the patients were given secondary treatment following early treatment in the combat area. To give a more accurate estimate of the true mortality, one should add the immediate mortality of 6.1 per cent, as re-

TABLE 1

REVIEW OF PENETRATING CHEST TRAUMA IN CIVILIAN EXPERIENCE

Author	Year	No. of Patients	Per cent Mortality (With Associated Injury)	Per cent Mortality (No Associated Injury)	Incidence		
					Hemothorax	Pneumothorax	Hemopneumothorax
Farringer and Carr	1953	251	10.0	...	...	...	...
Steward	1942	297	13.8	...	...	...	...
Hardt and Seed	1942	280	17.3	7.3*	36.6	...	77.2
Cato and Norman	1940	276	25.3*	8.7*	13.8	...	...
Steinke	1939	87	28.7	11.6	36.7	6.9	11.4
Connors and Stenbuck	1933	109	20.1	...	...	...	...
Boland	1922–35	1009	13.0	8.5	25.0	19.0	38.0
Elkin and Cooper	1936–42	1132	6.4	...	38.0	18.0	35.0
Current series	1948–57	776	3.8	0.9	17.7	17.4	60.5

* After twenty-four hours.

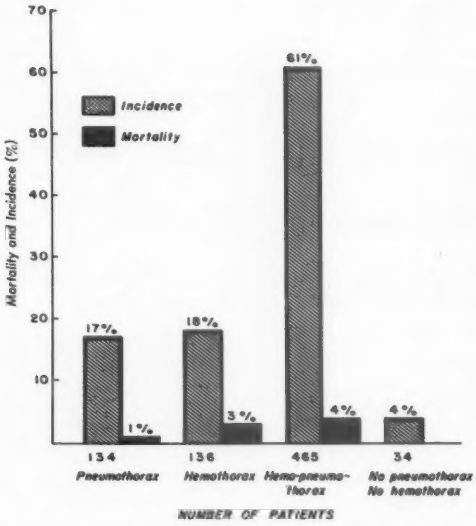

FIG. 1. Penetrating chest wounds. Immediate complications.

ported by Sako [13] for injuries limited to the chest in the Korean theater. The mortality from penetrating thoracic injuries in World War II was approximately 12 per cent, a great improvement over the 40 to 50 per cent mortality described in World War I [3].

The most common wounding agent in our series was the "switch blade" knife. The etiologic agent had a major bearing on the mortality rate. Although knife wounds were the most frequent, they were the least serious (Table II), resulting in a mortality of 1.6 per cent. Similarly, ice pick injuries had a mortality of only 2.4 per cent. Shotgun blasts were the most serious, being attended with a mortality of 32 per cent among nineteen patients. Bullet wounds resulted in an intermediate mortality of 7.6 per cent.

TABLE II
ANALYSIS OF WEAPONS PRODUCING INJURIES

Cause of Injury	No. of Patients	Mortality (per cent)
Knife	475	1.6
Bullet	170	7.6
Ice pick	82	2.4
Shot gun	19	32.0
Miscellaneous	23	0
Total	769	3.8

PNEUMOTHORAX, HEMOTHORAX AND HEMOPNEUMOTHORAX

Seven hundred and thirty five patients had a demonstrable hemothorax or a pneumothorax. Of the remaining thirty-four, twenty had evidence of a pulmonary hematoma. Two patients who had bullet wounds had mediastinal emphysema, eight had subcutaneous emphysema, two had cardiac wounds and one had a fractured rib.

Pneumothorax without hemothorax was demonstrated in 134 patients, while 136 patients showed evidence of a hemothorax without pneumothorax. The largest group, 465 patients, had both air and blood in the pleural cavity. (Fig. 1.)

Many patients lacked clinical evidence of either air or blood in their pleural space on admission but developed these complications later. It was thus imperative not only to follow these patients meticulously by clinical examination but also by serial roentgenograms following admission.

The smaller the inflicting agent the more frequent was the finding of a pneumothorax without hemothorax. Thus 51 per cent of the ice pick wounds showed *only* air, as compared to 16 per cent of knife wounds and 11 per cent of the shotgun injuries. Conversely, only 1 per cent of the bullet wounds resulted in a leakage of air without the collection of pleural blood.

The left hemithorax was injured more frequently than the right. There were 439 injuries to the left side of the thorax as compared to 260 to the right. Twelve patients had bilateral injuries.

Subcutaneous emphysema was detected by clinical or roentgenographic examination in 274 patients, (35.6 per cent). This was directly related to the size of the penetrating object as only 22 per cent of the patients with ice pick wounds had this complication as compared to 68 per cent with shotgun injuries.

Mediastinal emphysema occurred in twenty-four patients. Twenty of this group had suffered knife wounds and four patients had been injured by bullets.

TREATMENT

These patients were treated primarily by the surgical residents under the supervision of the visiting staff. We did not take part in

the treatment of each patient included in this series.

The plan of treatment was basically that described earlier from the same hospital [7], "The principal considerations in the treatment of all chest injuries are, first, the treatment of shock, second the restoration of normal cardiorespiratory physiology and third, the treatment of any complication or sequelae which may arise. . . . "

On admission to the emergency ward, all patients were inspected for the presence of a traumatopneic wound. If present, it was immediately covered with vaseline gauze and other occlusive dressings were applied.

The cardiorespiratory status was assessed early. If shock was present, its treatment was started immediately. One-third (240) of our patients were hypotensive (systolic blood pressure below 100 mm. Hg) on admission. As pointed out by Skinner [15], it is futile to try to correct hypotension by transfusion alone in the presence of either a traumatopneic wound or a massive pneumothorax, since these conditions produce a physiologic hypotension which is not related to a decrease in effective blood volume. Alcoholic patients with a mild pneumothorax were often moderately hypotensive on admission. In some instances, the blood pressure of these patients rose if the patient remained supine and inactive for a short time.

When shock had been assessed and treated and any major alterations in the intrapleural pressure adjusted, external lacerations were sutured, and obvious wounds were debrided and usually closed.

All patients received tetanus antitoxin, 1,500 units, after a negative skin test.

Roentgenograms of the chest were taken early if the condition of the patient permitted. Morphine was usually unnecessary for relief of pain in the early phases of treatment and was seldom ordered.

Antibiotics were administered to all patients. The type and amount given did not appear to alter the febrile response or the length of the hospital stay. Until 1956, it was routine to inject aqueous penicillin and streptomycin into the pleural space after each aspiration. This practice has been discontinued as a routine procedure since its value has remained equivocal.

Although differences in opinion exist regarding the early care of penetrating trauma, it is our belief that the most important principle is early and, if necessary, repeated or continuous aspiration of fluid and air from the pleural cavity. Unless the patient has marked dyspnea or evidence of massive collections of blood or air, a thoracotomy tube has not been used as initial treatment. Many patients had as much as 2,000 ml. of blood removed at one aspiration without ill effects. Repeated aspirations were performed, if necessary, to keep the pleural space free of fluid. A total of 3,000 to 4,000 ml. were aspirated from several patients over a three week period. Repeated clinical and roentgenographic examinations followed the course of the pleural fluid and the underlying lung. One hundred and eighty-six patients required the insertion of an intercostal drainage tube with a water seal. Indications for closed thoracotomy were: (1) tension of rapidly recurring pneumothorax, (2) traumatopneic wounds, (3) rapidly progressive, massive subcutaneous emphysema, (4) preparation prior to laparotomy in any thoracico-abdominal injury, (5) massive or recurring hemothorax following repeated aspirations. The tube was usually removed by the third or fourth day.

Fifty-nine per cent of our patients required aspiration or the insertion of an intercostal tube. There can be very little doubt that the principle of aspiration or tube drainage has resulted in a lowering of the complication rate in this series and in that of others [3, 15, 16].

RESULTS

Empyema developed in 25 patients (3.3 per cent). (Table III.) Of these patients, nineteen had been treated with intercostal tubes and six by aspiration alone. A low grade fever developed in many during the first seven to ten days after injury, but empyema did not become clinically evident in the majority of

TABLE III
MEDIAN HOSPITAL STAY

Type of Treatment	Median Hospital Stay (Days)
Antibiotics Only	4.3
Single Thoracenteses	3.0
Multiple Thoracenteses	5.8
Tube Drainage	9.5

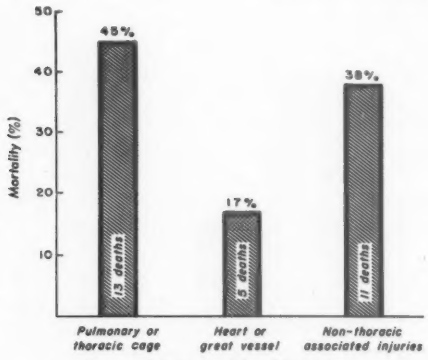

FIG. 2. Nature of fatal injuries.

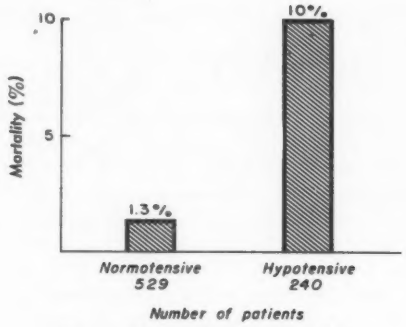

FIG. 3. Hypotension on admission.

these patients. The hospital stay ranged from seven to 103 days.

Multiple thoracenteses were performed in 265 patients. Empyema developed in six of these patients (2.2 per cent). The incidence of empyema in those patients treated with a thoracotomy tube was 10.2 per cent. A single aspiration was sufficient in four-fifths of the patients and none of these developed empyema. This incidence of infection probably reflects the magnitude of injury in the above groups rather than the result of different types of treatment. The only treatment of 275 patients was the administration of antibiotics. The median hospital stay utilizing the various forms of treatment is shown in Table III.

Bronchopleural fistulas developed in fourteen patients. Most of these closed spontaneously by the end of the second week. One remained open for ninety-two days in a patient with empyema; closure was then spontaneous.

No mediastinal abscess resulted among the twenty-four patients with mediastinal emphysema nor did any subcutaneous abscess develop among the 274 patients with subcutaneous emphysema.

MORTALITY

The over-all mortality among the 769 patients was 3.8 per cent. The causative factors were injuries to the (a) pulmonary and thoracic cage 45 per cent, (b) cardiac and great vessels 17 per cent, and (c) non-thoracic associated injuries 38 per cent. (Fig. 2.)

Among the 240 patients (31.2 per cent) who were hypotensive on admission, the mortality was 10 per cent. Five hundred and twenty-nine patients (68.8 per cent) were not suffering from evidence of shock and the over-all mortality in this group was only 1.3 per cent. (Fig. 3.)

Although hemorrhage was usually the primary or contributing cause of hypotension, Table IV indicates the basic cause of hypotension in twenty-seven patients in whom hemorrhage was not the chief factor. Furthermore, in the majority of patients who died, hemorrhage was not the cause of death and probably not the cause of hypotension.

It is natural that the incidence of hemorrhage and shock was related to the nature of the injuring force. Only 12 per cent of the patients with ice pick wounds, 29 per cent with knife

TABLE IV
SHOCK UNEXPLAINED BY HEMORRHAGE

Type of Injury	Primary Cause of Hypotension				
	Pericardial Tamponade	Tension Pneumothorax	Unexplained Except For Pneumothorax	Alcoholism	Injury to the Central Nervous System
Penetrating injury	9	4	8	6	0

wounds and 44 per cent with bullet wounds were hypotensive on admission, but 63 per cent wounded by shotgun blasts were hypotensive.

The mortality was significantly increased when there were associated injuries. (Fig. 4.) When there was none, the mortality was only 0.9 per cent among 654 patients, whereas the mortality was 66.6 per cent among patients with injuries to four associated organs. There were nineteen splenic injuries and twenty-three hepatic injuries with eight deaths (19 per cent mortality). Including the forty-two patients above, there were eighty-four major abdominal operations with eleven deaths (13 per cent mortality). Forty-nine penetrating thoracico-abdominal injuries were associated with a 14 per cent mortality. Twenty-two patients had penetrating wounds of the heart with five deaths (23 per cent mortality). There were no deaths among the twenty-four patients with mediastinal emphysema. Nineteen thoracotomies were performed (thirteen immediate and six delayed) with seven deaths.

The mortality among those with hemopneumothorax was 4.3 per cent, hemothorax 2.7 per cent and pneumothorax alone 1.4 per cent. (Fig. 1.) The average length of hospitalization increased by 100 per cent when the complication of hemothorax was added.

Four hundred and thirty-one of these patients were seen in less than one hour, 122 from one to four hours, forty-four from four to twelve hours. The mortality rate was 4.6 per cent in those seen in the first hour, 0.8 per cent when seen from one to four hours and 2.3 per cent in those seen from four to twelve hours. There was, obviously, a marked preselection represented by these figures as the most seriously injured patients were rushed to the hospital.

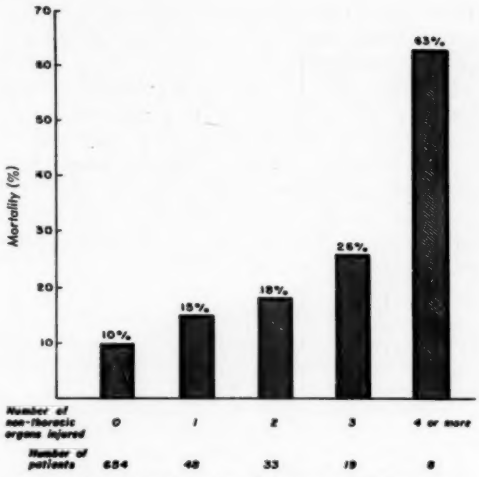

FIG. 4. Associated injuries. Effect on mortality rate.

It is of interest to note the trends which have occurred in this hospital in the management of 2,910 patients since 1922. The changes (Table v) include an increase in the use of closed thoracotomy and in the over-all efforts to empty the pleural space. No improvement was noted in the incidence of empyema, but the mortality has steadily decreased. Other trends include the increased use of bronchoscopy, tracheostomy and of translaryngeal aspirations with catheters, as well as transfusion and antibiotic therapy. Perhaps the most significant factor has been the improvement in bedside care provided by an expanded and better trained resident staff.

SUMMARY

Seven hundred and sixty-nine patients have been treated for penetrating injuries of the

TABLE V
EXPERIENCES IN A SINGLE HOSPITAL
(1922–1957)

Surgeons	Year of Survey	No. of Patients	Incidence (per cent)			Mortality Rate	Hospital Stay (Days)
			Pleural Aspiration	Closed Thoracotomy	Empyema		
Boland	1935	1009	18.0	0	1.6	13.0	...
Elkin and Cooper	1942	1132	8.0	0	2.0	6.4	17.0
Current series	1957	769	22.7	35.9	3.3	3.8	10.7

chest in a civilian hospital since 1948. In this group there were twenty-nine deaths (3.8 per cent). Among the 654 patients whose injury was limited to the thorax, the mortality was only 0.9 per cent. Twenty-five patients developed empyema, an incidence of 3.3 per cent.

The mortality in this hospital immediately prior to 1935 (1,009 patients) was 13 per cent, prior to 1942 (1,132 patients) was 6.4 per cent, as compared to the current mortality (769 patients) of 3.8 per cent.

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Severe Non-Penetrating Injuries to the Chest

CLINICAL RESULTS IN THE MANAGEMENT OF 216 PATIENTS

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THIS is a report of the results of treatment of 216 patients admitted to a surgical service of Grady Memorial Hospital during the decade 1948 through 1957. All patients with minor injuries, such as simple fractures of ribs or simple fractures of clavicles which were treated on an out-patient basis, have been excluded from this survey. Instead, this experience is based on patients with the problems presented by flail chest, hemothorax, pneumothorax, atelectasis and intrapulmonary hemorrhage. Among the 216 patients are four whose manifestation of blunt injury was limited to subcutaneous emphysema.

Blunt injuries of the thorax represent different problems from those associated with penetrating injuries. In general, the non-penetrating thoracic injury is a more severe injury than that resulting from penetrating trauma. The mortality is higher in the former group and the hospital stay is longer. This is due in part to the high incidence of associated injuries in the non-penetrating type.

Grady Memorial Hospital is a county hospital serving the metropolitan Atlanta area. This function explains the fact that 769 patients were admitted during the same decade for treatment of penetrating injuries of the thorax, the ratio of penetrating to blunt injuries being four to one. Such a ratio is probably found only in the city and county hospitals or in the military hospitals in time of war.

Among the patients admitted with blunt injuries were 165 men and fifty-one women, a ratio of three to one. The age range was fourteen months to eighty-nine years.

COMMENTS

In analyzing the causes of the deaths, the following factors were considered.

Age and General Health of the Patients. Except in the very old, the age of the patient did not appear to play a significant role in the cause of death. There was, however, a higher mortality in the first two decades among those patients who were pedestrians hit by automobiles. This resulted in a more severe form of injury and, therefore, a higher mortality. (Fig. 1.)

Similarly the general health of the patient did not play a demonstrable role except in an occasional instance. For example, the death of one patient who had chronic alcoholism with a minimal pneumothorax was attributed to delirium tremens.

Mode of Injury. The nature of the causative force permits a generalized prognosis. Among the twenty-six pedestrians who were hit by an automobile, the mortality rate was 46 per cent, the highest among the various forms of injury. (Fig. 2.) A mortality rate of 27 per cent resulted among the 110 patients who had been passengers in automobile accidents. Both types of automobile accidents accounted for 63 per cent of the blunt injuries but 81 per cent of the total resultant deaths. Of twenty-nine patients injured from crushing blows or fights, 14 per cent died while only 10 per cent of the fifty-one patients injured in falls had a fatal outcome.

The basis for these results is sometimes evident. Passengers in an automobile accident may be thrown directly against the steering

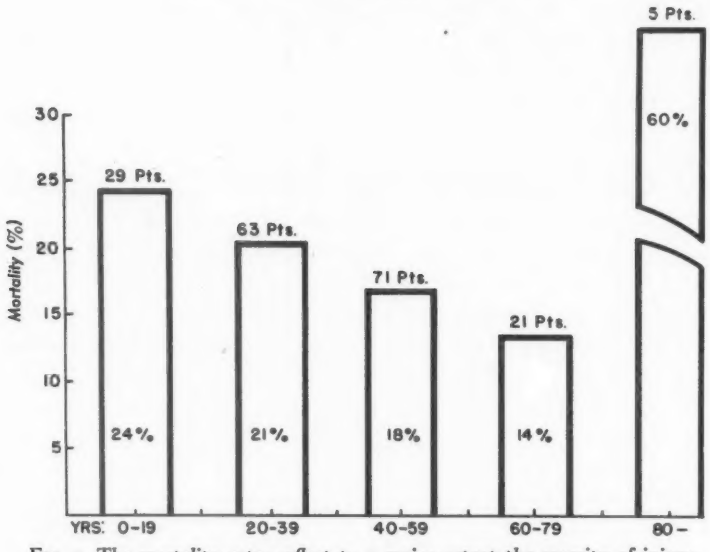

FIG. 1. The mortality rates reflect to a major extent the severity of injury peculiar to the given ages.

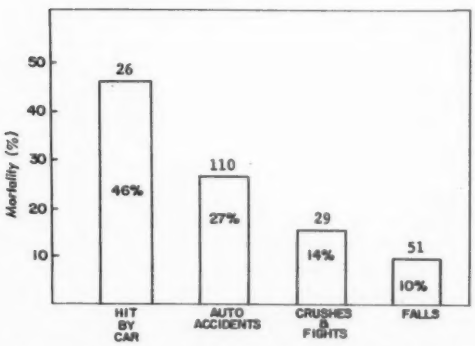

FIG. 2. The first bar represents the mortality rate among pedestrians struck by automobiles. The second bar reflects the injury incurred by passengers within automobiles involved in traffic accidents. The third bar represents the mortality of crushes and fights, while the fourth bar that of falls. (The number above each column indicates the number of patients.)

wheel or dashboard accounting for primary thoracic injury. However, an automobile seldom strikes a pedestrian directly in the thoracic area but lower, so that the thoracic injury is secondary and may be associated with serious injuries of the extremities, abdomen, or head.

The Magnitude of Thoracic Injury. The degree of thoracic injury can be estimated by the magnitude of the causative force as described above. More specifically, however, it can be described by the cite of injury, number of fractured ribs, and the presence of hemothorax, pneumothorax, or pulmonary hematoma.

Injuries to the left side of the thorax were more serious than those to the right side. (Fig. 3.) In the thirty-nine instances in which injuries where limited to the right side of the chest, there was only one fatality (3 per cent), while in the sixty patients in whom there was a single injury to the left side there was a 10 per cent mortality. Perhaps the position of the heart accounts for this distinction but this relationship was not clinically obvious. Among thirty-six patients in whom there were multiple injuries to the right side the mortality was essentially the same (33 per cent). Of forty-eight patients who had injuries to both sides of the thorax, the mortality was 42 per cent.

The mortality associated with hemopneumothorax is much higher in patients with blunt trauma than in those with penetrating injuries. Of 112 patients with hemopneumothorax from blunt injury, the mortality rate was 49 per cent (Figure 4), whereas, among the patients with penetrating injury, it was only 4 per cent [2]. Forty-three patients had a hemothorax without a pneumothorax; the mortality was 21 per cent compared to 2.7 per cent after penetrating injuries. Forty-eight

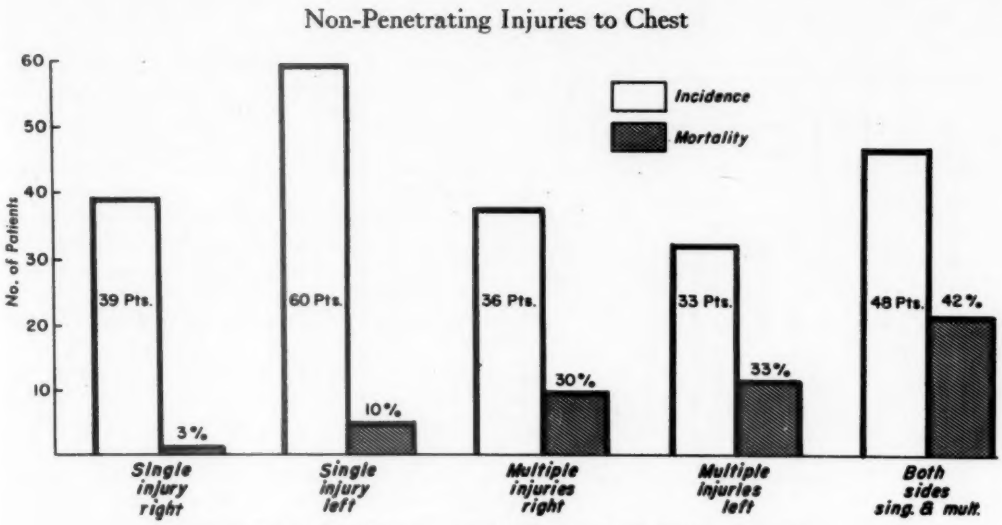

FIG. 3. The unshaded bar represents incidence, the shaded bar mortality.

patients had a pneumothorax without a detectable collection of blood in the pleural space. Among this group, the mortality rate was 14 per cent as compared to 1 per cent in the group with penetrating injuries. Nine patients had clinical and radiographic evidence of pulmonary hematomas without a pneumothorax or a hemothorax. Four other patients had subcutaneous emphysema without radiographic evidence of pneumothorax, hemothorax, or pulmonary hematoma. There were no deaths in the last two groups. Since there was no external wound in the last four patients, there was evidently a leak from the lung into the subcutaneous tissues, but a pneumothorax was not demonstrable radiographically. A number of patients who were admitted early with subcutaneous emphysema later developed a demonstrable pneumothorax.

Number of Ribs Fractured. The number of ribs fractured provides an index as to the relative force of the injury and therefore of the prognosis. One hundred seventy three patients had fractured ribs. These injuries ranged from one to seventeen fractured ribs in each patient. Eleven of forty-three patients (26 per cent) who suffered no fractured ribs died; the maiority died from a severe non-

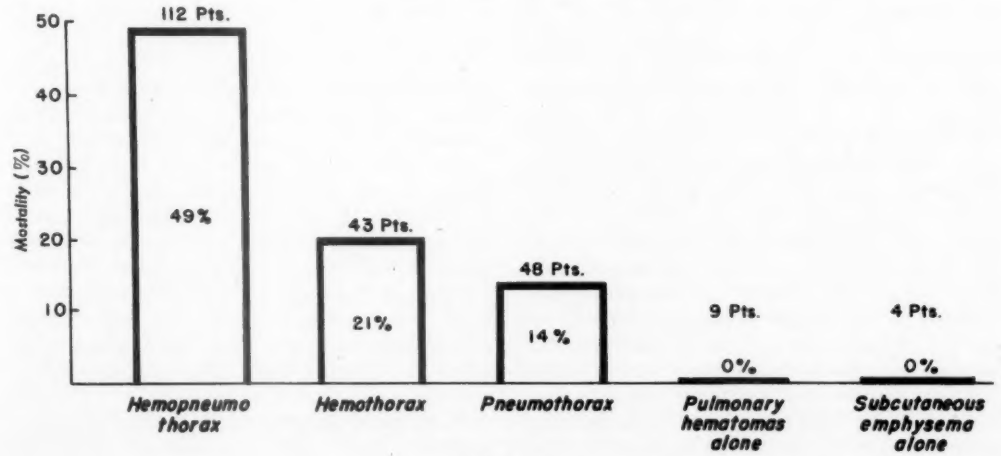

FIG. 4.

TABLE I

Rib Fractured*	No. of Patients	Mortality (per cent)
First	14	36
Second	38	29
Third	54	20
Fourth	70	
Fifth	75	
Sixth	69	
Seventh	77	
Eighth	69	
Ninth	53	
Tenth	35	
Eleventh	18	
Twelfth	8	
Total	580	

* The mortality among the forty-three patients who did not have fractured ribs was 26 per cent.

thoracic injury. Table I shows the frequency with which each rib was fractured. In twenty-two patients the detailed information is not available.

The mortality among the 96 patients having only one or two ribs fractured was 16 per cent, compared to 27.5 per cent among the 120 patients with three or more rib fractures. Of those who had a fracture of the first rib, 36 per cent died while 29 per cent of those with fractures of the second rib died. This probably reflects the premise that a more severe injury is required to fracture the first and perhaps second ribs.

Unilateral Hemothorax. There were 151 patients who had a unilateral hemothorax either with or without a pneumothorax. Of these 151 patients, twenty had been hit by an automobile, seventy-nine were passengers in an automobile accident, thirty-three had suffered falls, and nineteen had received crushing blows to the thoracic wall. The mortality again was higher in those hit by automobiles (50 per cent), next highest in the automobile passenger, accidents (24 per cent), next in those caused by crushing blows (21 per cent) and least, those due to falls (9 per cent). The over-all mortality in these patients with unilateral hemothorax (with or without pneumothorax) was 24 per cent while the average hospital stay in this group was eleven days and the median hospital stay was six and a half days. However, including only those who survived, the average hospital stay was fourteen days and the median was eight days. The deaths occurred in an average of three days but the median time of death was within the first twenty-four hours.

Bilateral Hemothorax. Only fourteen patients in this group suffered a bilateral hemothorax but the resulting mortality was 57 per cent. The average length of time spent in the hospital was twenty-three days. Those patients who did not survive had an average of 2.6 days of hospitalization. Seven of these patients, three of whom died, sustained injuries due to the automobile. The average hospital stay of these seven was thirty days. Among those who died, the average was 3.6 days. None of the patients' injuries due to falls had a bilateral hemothorax but two patients were crushed by heavy objects, both surviving the bilateral hemothorax, the average hospital stay being only eleven days.

Pneumothorax. Pneumothorax developed in 159 patients and several had hemothoraces as well. Thus, the incidence of pneumothorax among the injured patients was 74 per cent and the mortality was 21 per cent. Among the forty-nine patients who had a pneumothorax without hemothorax, the mortality was 20 per cent. The incidence of this single complication among the over-all group was 23 per cent. Among the survivors, the average hospital stay of those patients with uncomplicated pneumothoraces was nine days while the median stay was six days. Only three of those with an uncomplicated pneumothorax had a tension pneumothorax and one died. All three of the patients had suffered automobile accidents.

Subcutaneous Emphysema. No significant correlation could be made relating the incidence of the subcutaneous emphysema to the mortality. It was a complication found among 43 per cent of the patients with automobile accidents, 42 per cent of the patients hit by automobiles, 45 per cent of the patients suffering falls and 46 per cent of patients suffering crush or heavy blows. The mortality in these groups paralleled the over-all mortality found with each traumatic force. The presence of subcutaneous emphysema seems to have little value in predicting the degree of injury or the prognosis.

Mediastinal Emphysema. Among fourteen patients (7 per cent) who had demonstrable mediastinal emphysema, four patients died

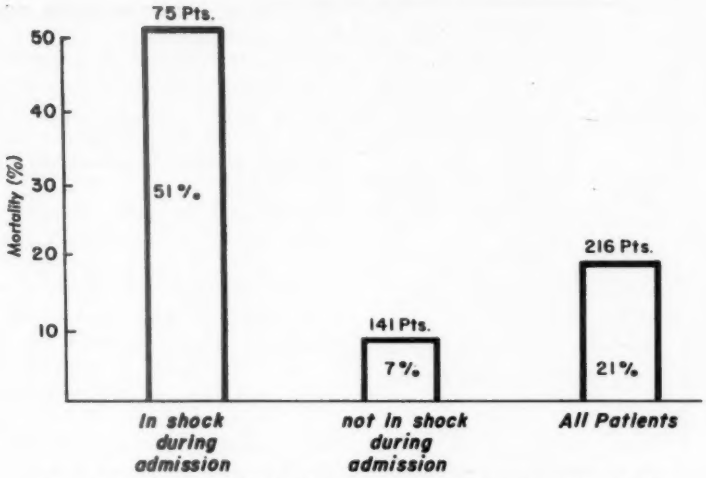

FIG. 5. This illustrates the incidence of shock on admission and mortality.

(29 per cent). Of these four deaths, three resulted from automobile accidents and one from a crushing injury.

Esophageal Injuries. None of the patients in this group had an esophageal injury directly attributed to the thoracic trauma. One patient, a sixteen year old boy, suffered severe cranial injuries including multiple hemorrhages and contusions of the brain, an epidural hematoma, and subarachnoid hemorrhages. Except for minimal subcutaneous injuries, there was no outward evidence of thoracic injury. On the fourth day he became quite febrile and a rapid pulse and respiration developed. Roentgenograms of the chest revealed a small collection of fluid at the left pleural base. The patient died on the tenth day after injury. Autopsy revealed a longitudinal perforation of the esophagus, measuring 3 cm., in its lower third immediately above the diaphragm. Spillage of gastric contents into the left pleural cavity and into the anterior mediastinum had resulted. The exact time of rupture is uncertain. It is possible that this had been a primary result of injury, but it is believed that this was a complication of the severe head injury with perforation having occurred on the fourth hospital day.

Tracheal Injuries. Only one patient had an intrathoracic tear of the trachea. This was due to an automobile accident and was associated with a bilateral hemopneumothorax. Rupture of the trachea at the carina resulted. The patient died on the third hospital day [1].

Chylothorax. Although there are numerous reports of chylothorax following injury, this complication was not diagnosed in this series of patients.

Other Injuries to the Chest Wall. Because of the selection of patients admitted to the hospital, only eighteen of the 216 patients with thoracic injuries had fractures of the clavicle, nine of whom died. None of these patients had demonstrable lacerations of their subclavian vessels. The two patients with bilateral clavicular fractures due to automobile accidents lived.

Sternal fractures were diagnosed in only nine patients; four of whom died. It is probable that others had such fractures for special roentgenographic views of the sternum were seldom taken.

There were eight fractures of the scapula, one resulting from a fall and seven from automobile passenger or pedestrian accidents. One patient fractured both scapulae. None of the patients with scapular fractures died.

Cardiac Injuries. In the earlier years of this survey, routine electrocardiographic studies were not made on these patients. These were done frequently, however, in the later years. Nevertheless, only nine patients in this group were definitely diagnosed as having cardiac injuries. Four of them died, and the cardiac injuries in each appeared to be only a mild contusion and were not considered the primary cause of death. Automobile accidents accounted for each of the cardiac injuries. One patient, a twenty-five year old man, had an acute onset

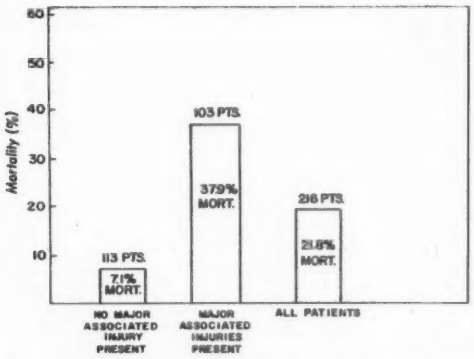

FIG. 6. The effect of major associated injury on mortality is shown.

of aortic insufficiency following an automobile accident. He developed progressive electrocardiographic findings of left ventricular hypertrophy over a period of four months. At the end of this time, he was being maintained on digitalis but continued to develop signs of congestive cardiac failure. It is believed that he had suffered a rupture of his aortic valve.

Hypotension. Shock provided a rather definite index to the degree of injury, proving to be a very grave prognostic sign following blunt injuries of the chest. Seventy-five of these patients were hypotensive (systolic blood pressures of 100 mm. Hg or less) at the time of admission. Fifty-one per cent of these died even though every effort was made to provide appropriate therapy. This mortality figure compares strikingly with a 7 per cent mortality among the remaining 141 patients who were not hypotensive on admission. (Fig. 5.) Shock was present on admission in seventeen (65 per cent) of those hit by an automobile, the resultant mortality being 76 per cent. It was noted early in forty-three (39 per cent) of those in passenger automobile accidents, the resulting mortality being 49 per cent. Six (12 per cent) of those injured by falls were in shock with a resultant mortality rate of 33 per cent.

Patients Without Associated Injuries. In order to better evaluate blunt thoracic injury *per se* a survey was made of those patients suffering thoracic injuries without any major associated injury. There were 113 patients in this category, an incidence of 52 per cent of the entire group. Among these 113 patients there were only eight deaths, a mortality rate of 7 per cent. (Fig. 6.) This contrasts sharply to the mortality rate of 22 per cent among the over-all 216 patients or to a mortality rate of 38 per cent among 103 patients who had at least one major associated injury. The eight fatalities previously mentioned are summarized in Table II.

Associated Injuries. As mentioned above, major injuries to multiple parts of the body were identified in 103 patients (48 per cent). In thirteen (28 per cent) of the resultant forty-seven fatalities, the death was due primarily to either major injury to the brain or to a major abdominal injury. These thirteen patients would almost surely have died regardless of the thoracic injury. Of the remaining thirty-four patients with associated injuries, twenty-six had associated injuries of major import although the thoracic injury probably contributed to the death of the patients. Sixteen patients had laparotomy for the repair of intra-abdominal injuries. Nine of these sixteen patients died.

Treatment of Injuries. The majority of the patients in this series were treated primarily by the resident surgeons under the supervision of the visiting staff. We treated a minority of the patients. The purpose of this report is not to present new forms of treatment, but to evaluate the results of standard treatment in a large group of patients. Thoracentesis, closed thoracotomy drainage, bronchoscopy, tracheostomy, skeletal traction, and mechanical respirators have been used in the management of these patients. Open thoracotomy was indicated in only three of the 216 patients. Two of them had continued to have intrathoracic bleeding following massive transfusion, and laparotomy as well as thoracotomy were performed since severe intra-abdominal injuries were also present. Both of these patients died. Generally speaking, the method of treatment was the most conservative possible. Thoracentesis was used in preference to closed drainage when it appeared that either might result in re-expansion of the lung and emptying of the pleural space. Closed thoracotomy was used when there was evidence of tension pneumothorax, massive hemothorax, or continued hemothorax or pneumothorax following repeated thoracenteses. As a rule, when collections in the pleural cavity were relatively small, but recurred, closed thoracotomy was

TABLE II

MORTALITY IN BLUNT CHEST TRAUMA

(No major associated injuries)

Case No.	Age (yr.)	Survival Time after Accident	Cause of Injury	Ribs Fractured	Pneumothorax	Hemothorax	Early Shock	Treatment	Remarks
1	52	4 days	Fall	None	Yes*	No	No	Observation, antibiotics	Chronic alcoholic with advanced, arrested TB; delerium tremens
2	44	3 days	Auto accident	Multiple, bilateral; fracture of sternum.	Yes	Yes	Yes	Bilateral closed thoracostomy, tracheostomy, sternal traction	Autopsy revealed rupture of trachea at carina
3	39	18 days		R-6, 8, 9, 10, 12 L-7, 8	Yes†	No	No	Observation, antibiotics	Died unexpectedly and suddenly on the eighteenth hospital day; pulmonary embolus suspected
4	54	30 min.	Hit by car	R-2, 3, 4, 5 L-1, 2, 3	No data	Yes‡	Yes	Observation, antibiotics	Had multiple superficial lacerations, skull fracture, pelvic fracture, but no brain or abdominal injury
5	84	3 days	Hit by car	Multiple, bilateral	No	No	Yes	Transfusion, antibiotics	Cause of death unknown
6	37	10 days	Auto and train	R-2, 3, 4, 5, 6; fracture of clavicle	Yes	No	No	Tracheostomy, bronchoscopy, antibiotics	Developed delirium tremens, pneumonia and lung abscess
7	82	10 days	Fall	L-2, 3, 4, 5; fracture of clavicle	Yes	No	Yes§	Closed thoracostomy drainage	Discharged seven days after injury; readmitted two days later with a tension pneumothorax right (opposite side) and died shortly after admission
8	45	3 days	Kicked and beaten	None	Yes	Yes	Yes	Tracheostomy, bronchoscopy, antibiotics	Rupture of trachea in neck (stellate fracture) and massive subcutaneous emphysema

* Minimal.
† Ten per cent.
‡ Bilateral.
§ Present on second admission.

used after the third thoracentesis. In addition, it was used in patients with bilateral hemothorax or pneumothorax of any significant extent. It was also used in patients with a single hemothorax or pneumothorax who had to be given a general anesthesia for repair of other injuries.

Of the 120 patients with major injuries limited to the chest, forty-six (38 per cent) required only observation while thirty-six (30 per cent) required only thoracentesis and thirty-seven (31 per cent) required closed thoracotomy drainage. Only one of these specific patients required an open thoracotomy. Tracheostomy was performed in only forty-three patients but was used frequently in the later years of this period. Bronchoscopy was also used more frequently in the later phase.

Empyema. Although the incidence of hemothorax was 71 per cent, only six of these patients developed clinically significant empyema (Table III). Many of the patients developed a febrile course during the first week of illness and several of these patients had positive cultures obtained from the pleural collections. Only six patients, however, developed a continuing infection which was definitively diagnosed as empyema. Four of these patients had been in automobile accidents, one in a motorcycle accident, and one had fallen. Each pa-

TABLE III
EMPYEMA

Causative Force	Closed Thoracostomy*	Fever	Antibiotics Administered (days)	Hospital Stay (days)	Result	Follow-up
1. Auto accident	4 days	11 days	11	11	Good	Well
2. Auto accident	0	31 days or longer	61	32	Fair	Resistant empyema requiring antibiotics as an out-patient
3. Motorcycle accident	0	19 days	18	18	Good	Well
4. Fell while intoxicated	0	37 days	37	79	Good	Required subsequent decortication
5. Auto accident	2 days	...	2	5	Died	Autopsy revealed empyema and hemothorax
6. Auto accident	5 days	...	6	6	Died	Autopsy revealed laceration of pulmonary artery, hemothorax and empyema

* All patients had multiple aspirations in addition.

tient had developed a hemothorax. Two of the patients died. Of the four patients who survived, only one had initially been treated by closed thoracotomy drainage; the others had received multiple aspirations. One patient required decortication and survived following a hospital stay of seventy-nine days. Antibiotics were initially administered to most of the patients included in this report. All the patients in whom empyema developed were given antibiotics. The low incidence of empyema is probably due more to eradication of pleural fluid and air rather than to the routine use of antibiotics. In addition, it is believed that the maintenance of pulmonary and tracheal hygiene through bronchoscopy and endotracheal aspirations played a significant role in minimizing intrapulmonary infection and secondary empyema.

Of the 216 patients, fifty-eight required transfusions ranging in amount from 1 unit of blood to 35 units. Thirty of the fifty-eight patients died (52 per cent). Ten (83 per cent) of the twelve patients who required over 2,000 cc. of blood died, indicating that the preceding hypotension was probably not due primarily to blood loss and, therefore, not responsive to transfusion.

SUMMARY

A survey of 216 patients with non-penetrating thoracic injuries over a ten year period is reported. The over-all mortality was 21 per cent. One hundred and thirteen patients suffered major thoracic injuries without major associated injuries. The mortality rate in this group was 7 per cent. The results of this survey emphasize that non-penetrating injuries to the chest remain a major factor in deaths from trauma. It behooves physicians dealing with this condition to utilize all diagnostic and therapeutic means available to reduce the mortality significantly. The majority of deaths resulted from multiple injuries of which the thoracic injury was only one component.

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Ruptured Intracranial Dermoid

REPORT OF A CASE AND SURVEY OF PREVIOUSLY REPORTED CASES

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THE rupture of an intracranial dermoid cyst is a perplexing problem with regard to its diagnosis and management, mainly because of the great variety of confusing clinical signs and symptoms. Therefore, in most instances, the diagnosis is only made during operation or at the necropsy table [25]. A survey of the reported cases in the literature revealed that the mortality is 100 per cent. It is considered benign, however, when recognized early, before rupture; the mortality is not as great if it is in an accessible location and removed immediately.

The main purpose of this report is to describe a rather unique case of ruptured intracranial dermoid with its interesting clinical signs and symptoms. The ten patients previously reported in the literature, died so soon that a thorough study of the course of this disease process was impossible. The case being reported here is outstanding in that the course of the pathology was extended over a four-week period from onset to eventual death. This afforded an ample time for a thorough study of the signs and symptoms. It is hoped that this study will aid in outlining a clinical picture which will help in the earlier diagnosis and, therefore, more effective treatment of this potentially remediable process can be instituted. Furthermore, it is hoped that this report will stress the fact that a successful outcome is not to be anticipated following conservative treatment.

CASE REPORT

E. G., a forty-five year old white, right-handed woman, was admitted to the hospital on December 10, 1956, with the chief complaint of progressive somnolence and disorientation of twenty-four hours' duration.

As a child, she had a history of one major convulsive seizure lasting for a few minutes. Eight months prior to admission she had her second convulsive seizure with loss of consciousness, biting of the tongue and urinary incontinence. Five months later she complained of intermittent, pulsating, generalized headaches, associated with nuchal rigidity, for which she was being treated by her physician as having cervical arthritis. An insidious change in her personality was noted since then; she was irritable, withdrawn and seclusive. Twenty-four hours prior to admission she had severe generalized headaches and became disoriented and lethargic.

Physical examination revealed a well developed and well nourished forty-five year old woman who was disoriented and lethargic. The temperature was 99° F., pulse was 80, respirations were 24, and blood pressure was 180/90 mm. Hg. Examination of the head revealed no intracranial bruit, tenderness or exostosis. The neck was rigid, and carotid pulses were equal and intact. Examination of the heart revealed no enlargement, but a grade 2 apical systolic murmur was heard. The chest, abdomen and extremities were within normal limits.

On neurological examination, the patient was lethargic, incoherent and disoriented. Pupils were pinpoint and reacted poorly to light. Funduscopy revealed blurring of the left disc margin, but no papilledema or venous engorgement. The right disc was normal. The remainder of the neurological examination was normal.

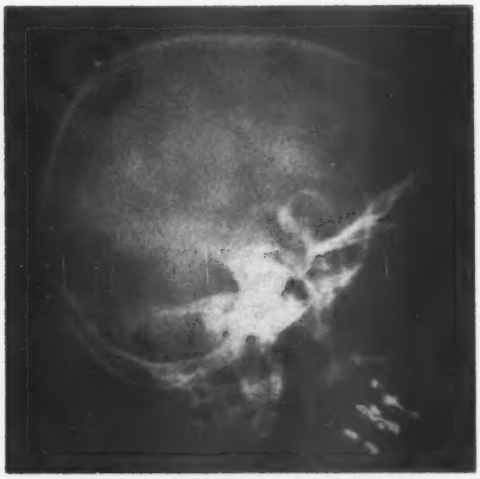

FIG. 1. Plain lateral roentgenogram of the skull shows a circumscribed calcified mass, roughly circular in shape, measuring approximately 1 inch in diameter at the base of the left frontal lobe, representing the calcified portion of the dermoid cyst.

Laboratory examination showed a hemoglobin of 15.4 gm. per cent, hematocrit of 50, a white blood count of 25,000 per cu. mm. (with 10 bands, 80 segmenters, 9 lymphocytes and 1 monocyte), and a sedimentation rate of 24 mm. corrected. The Wassermann test was negative, the blood sugar was 125 mg. per cent, non-protein nitrogen was 29 mg. per cent, total proteins were 6.9 gm. per cent with 3.1 gm. per cent albumin and 3.8 gm. per cent globulin. Blood smears and cultures were negative. Urinalysis showed the urine to be acid; albumin was 3 plus and the sediment showed a few granular casts. There were 8 to 10 white blood cells and no red blood cells. Serum potassium, sodium, chlorides and the carbon dioxide combining power were all within normal limits. Tuberculin test (1:1000) was negative in twenty-four and forty-eight hours. Lumbar puncture revealed an opening pressure of 540 mm. and a closing pressure of 390 mm. The cerebrospinal fluid was cloudy and turbid in appearance; smears and cultures for acid fast bacilli and other organisms in this fluid were negative. The cell count revealed 3,300 polymorphonuclears; cerebrospinal fluid proteins were 550 mg. per cent, sugar was 43 mg. per cent and chlorides were 108 mEq. per L. Roentgenograms of the chest were within normal limits; and roentgenograms of the skull showed a circumscribed calcific mass, roughly circular in shape, measuring approximately 1 inch in diameter, lying at the base of the left frontal lobe. Basal views of the skull were within normal limits. (Fig. 1.)

Hospital Course. With the presumptive diagnosis of meningitis secondary to a cerebral abscess or infected neoplasm, she was treated symptomatically with massive doses of antibiotics such as penicillin, Chloromycetin,® streptomycin, cortisone and fluids despite our failure to find the causative organism. Neurosurgical intervention was postponed due to the moribund condition of the patient. By the end of the first hospital day a temperature of 102°F. developed, vital signs were unstable, and she was comatose. Both pupils were fixed and dilated, and corneal and deep tendon reflexes were completely absent. On the fourth hospital day she regained consciousness and complained of severe headaches. There were corneal ulcerations, and right peripheral third, sixth, seventh, and tenth cranial nerve palsies. Repeated examinations of the urine, blood and cerebrospinal fluid revealed no significant change from the previous results. Symptomatic treatment was continued and, on the fourteenth hospital day, she suddenly became stuporous and lapsed into coma. Grade 3 bilateral papilledema, conjugate deviation of the eyes to the right, and right-sided twitchings of the face developed followed by generalized convulsions. She was brought immediately to the operating room, and a left percutaneous angiography revealed the presence of a rather large left frontotemporal mass.

Operation. Under local anesthesia a tissue flap was made over the left brow in the subperiosteal plane and a free bone plate was lifted. The dura was moderately tense but, otherwise, showed no gross abnormality. The dural flap was turned back towards the midline and the brain protruded into the wound quite noticeably.

The striking finding on examination of the cortex was the presence of small lobules of yellowish material in the subarachnoid space between the convulutions. These were free, had a glistening appearance, and measured from 1 to 3 mm. in diameter. There was no other discernible abnormality except the edema, and a search along the sphenoidal ridge, the falx and floor of the middle fossa was unrewarding. A small cortical incision was made in the frontal region, and a needle was inserted and directed toward the calcification. At a depth of about 2 cm., turbid fluid was encountered which contained considerable debris and much of the same yellowish material which was seen in the subarachnoid space.

The cortical incision was enlarged and a very thin-walled, cystic structure was found extending ahead of the motor strip to the base of the middle fossa. This cystic cavity contained fluid, much debris, and large clumps of amorphous yellow material in which were many short hairs. The entire contents of the cyst were evacuated and much of the wall of the cyst was excised. As it was traced downwards, the calcification was encoun-

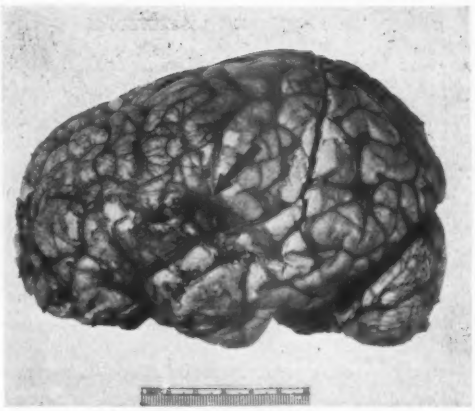

FIG. 2. Surgical defect in the left temporal lobe representing the site of the dermoid cyst.

tered. It was densely adherent to the region of the carotid artery and for this reason not all the calcified material was removed. A diagnosis of ruptured intracranial dermoid cyst with ventriculitis and meningitis was made.

Postoperative Course. On the fourth postoperative day, the patient was still unresponsive, even to deep painful stimuli, and completely areflexic. Severe convulsions developed and status epilepticus began. Her blood pressure was near zero. She was given Levophed,® anticonvulsants, and intravenous fluids. The positive pressure respiratory machine was used as respiratory failure developed. She did not regain consciousness and died on the thirteenth postoperative day.

Autopsy Findings. On postmortem examination, the dura mater covering the defect in the scalp was somewhat thickened, edematous and focally hemorrhagic. Old clotted blood was found in the subdural space at the region of the defect and extending from the base of the brain to the right parietal and temporal regions. The brain weighed 1,400 gm. The pia-arachnoid at the operative site, and at the region where the clotted subdural blood was found, showed moderate congestion. The defect at the left temporal region measured 10 by 9 cm. and was irregular in shape. (Fig. 2.) The base of this defect was made up of soft focally hemorrhagic and brownish brain tissue, and small yellowish and moderately firm plaques measuring up to 0.6 cm. were found scattered in this defect and in the surrounding brain surfaces in the subarachnoid space.

The gyri were moderately flattened and the sulci correspondingly narrowed. No anomalies at the circle of Willis were noted. Serial frontal sections, revealed a cystic defect in the region of the left temporal lobe. This defect measured 4 by 3 by

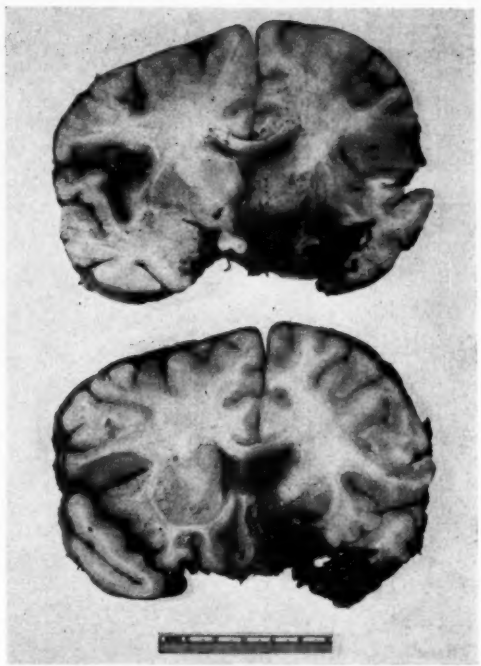

FIG. 3. Sagittal section, at the level of surgical resection, shows extension into the left lateral ventricle of ruptured dermoid cyst.

3 cm. in size. It contained a grayish white, pasty material which also extruded into the adjacent leptomeninges. Similar pasty material was present in a tract which extended to the left lateral ventricle. (Fig. 3.) The walls of the cyst were gray in color and firm in consistency. Surfaces of the left lateral ventricle appeared reddish and inflamed. Elsewhere the cerebral tissues were not unusual. The midbrain and hindbrain, including the cerebellum, appeared grossly normal.

Histologic sections from the brain revealed remnants of the dermoid cyst in the left temporal lobe, partially lined by stratified squamous epithelium. (Fig. 4.) The cavity contained sebaceous material which was rich in cholesterol crystals. The same material was seen in the meninges, the surrounding parenchyma of the brain, and in the ventricles. The brain tissue itself was edematous and showed focal necrosis and hemorrhages. It was infiltrated by numbers of microglial cells and some neutrophils. The meninges were focally inflamed, and infiltrated by lymphocytes, macrophages and some neutrophils. Meningeal vessels were congested and some contained recently formed thrombi. The inflammatory changes also involved the meninges of the brain stem.

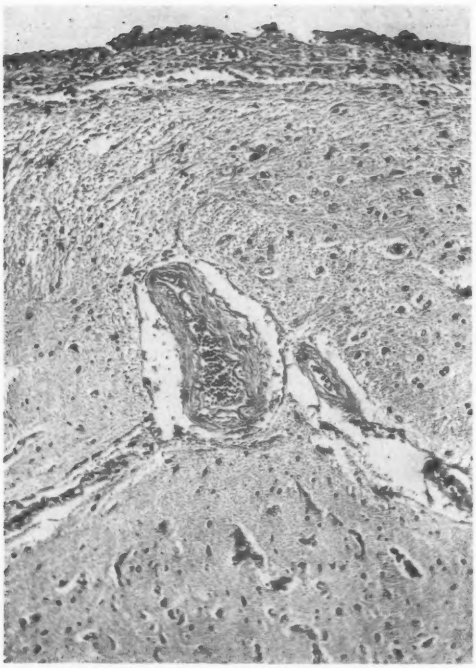

FIG. 4. Portion of wall of ruptured dermoid cyst, showing epithelial lining. Hematoxylin and eosin stain. Original magnification × 130.

Histologic sections of a portion of the wall of the cyst which was removed, revealed a focally calcified dermoid cyst. The cyst was partially lined by epithelium which in some places was of stratified squamous type and in others, columnar. Hair shafts were also present, and definite bone formation was noted in some places.

Comments. The lifelong history of convulsive seizures suggests that this patient had had the tumor since childhood. Dermoid cysts are congenital tumors which are present at birth and grow very slowly. They may be symptomless for a long period of time. A change in her personality, however, was noted several months prior to her admission. The dispersion of dermoid contents in the ventricular system and subarachnoid space caused a severe leptomeningeal reaction, accompanied by cerebral edema. This explains the stiffness of the neck, lethargy, stupor and disorientation. After conservative treatment she recovered from the initial shock of leptomeningeal reaction, but her condition actually was not improved but worse, in the sense that she developed severe arachnoiditis. This produced cranial nerve palsies which later were aggravated by cerebral edema followed by cerebellar and uncal herniation. Surgical intervention was too late to be effective.

CASES IN THE LITERATURE

The first intracranial dermoid cyst reported in the literature, in 1745, was that of Verratus. The patient was a fifty year old man who had a rather acute onset of apoplectiform symptoms with sudden loss of consciousness, fever and death. A dermoid the size of a pea was located in the left lateral ventricle, and it ruptured into the ventricular system causing severe ventriculitis and death [*2,5*].

Tannehain (1897) described a twenty-five year old woman who complained of sacral pains of five weeks' duration, followed by aphasia, rigidity of the neck, and signs of increase intracranial pressure which were followed by death. A pial type of intracranial dermoid which was the size of a clenched fist ruptured into the third ventricle dispersing its contents into the spinal canal [*5*].

Raymound's patient (1904) was a thirty-four year old man who had multiple dermoids. One was located on the medial surface of the right frontal region protruding into the lateral ventricle (the size of a hazel nut) and the other was located in the dorsal part of the spinal canal. The dermoid in the spinal canal ruptured dispersing its contents into the entire subarachnoid space and causing severe leptomeningeal reaction. The patient died of symptoms of increased intracranial pressure [*5*].

A forty year old woman who died of an acute cerebral hemorrhage was described by Winteler in 1910. A ruptured dermoid cyst, the size of a hen's egg was located in the cerebellum.

Schulgin (1911) reported the history of a fifty-one year old man who died of acute streptococcal sepsis. No information was given regarding the preceding neurological symptoms. Necropsy revealed an intracranial dermoid, the size of a walnut, which ruptured into the fourth ventricle.

Gorog's patient (1927) was a fifty year old woman who died of symptoms of ventriculitis. Necropsy revealed a ruptured dermoid which had perforated into the lateral and fourth ventricle.

Luas (1929) reported a case in a twenty-five year old man who had previously been treated for fifteen to twenty years of psychotic behavior. Mental deterioration developed, and he died suddenly. A dermoid measuring 7 by 7.5 by 6 cm., located at the base of the right

frontal lobe, had ruptured into the third ventricle.

Bauditz (1933) described a forty-eight year old man who died suddenly. An intracranial dermoid, located at the right temporo-pontine angle, had ruptured with dispersion of dermoid substances all over the base and into the fourth ventricle.

Scheinker's patient (1936) was a forty year old man. He had increasing intracranial pressure phenomena for three weeks, with aphasia, right-sided spastic hemiplegia, paresis of the seventh cranial nerve, exopthalmos, and ptosis of the left eyelid. The patient died of cerebral edema, and the dermoid, the size of a plum, was located at the base of the left frontal lobe extending into the lateral ventricle. It had ruptured into the left lateral ventricle.

Miller's patient (1950), a thirty year old man, was admitted to the hospital with nocturnal seizures, mental deterioration, frontal headaches, papilledema and ataxia. The patient died, and the dermoid located in the right frontal lobe had ruptured into the left lateral ventricle [*18*].

COMMENTS

Following Verratus's report on intracranial dermoid in 1745, Dumeril [*2*] (1807) reported an intracranial cyst, which did not contain hair, with an external pearly appearing capsule. Cruveilhier called them "Tumeurs Perlee." Joannes Muller (1838) called them cholesteatomas after having found cholesterol crystals in these tumors. Bostroem (1897), after extensive histologic examination on both tumors which did and did not contain hair, divided them into the following three categories: pial dermoid, dural dermoid and epidermoid. However, several theories evolved as to the origin of these types of growths. The first was that of Kimball and Courville, who believe that new growth of embryonic origin within the cranium may be divided into two groups. In the first group the tumor arises from residual cells of some specific structures such as the craniopharyngeal canal (craniopharyngioma) or the notochord (chordoma) and is always found in the region of the parent structures. Tumors of the second group apparently arise from the cell rests derived from the original tissue layers and are therefore confined to their special locality although they may show a predilection for a certain region. This group is made up of three types of tumors all of which are relatively rare, epidermoid, dermoid and teratomas.

Bostroem states that early amniotic adhesions might cause a local isolation or nest of or dermoid. The age of the anlage determines which of these two tumors would result at birth. If the anlage occurred at the third week of gestation a dermoid would result, and at the fourth to fifth weeks, the epidermoid.

Arey claimed that dermoids resulting from embryonic epidermal inclusion are not infrequent along the line of fusion of various embryonic structures such as the branchial groove, and any place along the mid-dorsal or the mid-ventral body wall. Certainly intracranial dermoids are most frequently seen in the midline; furthermore, their high incidence of location below the tentorium may give a clue to their origin.

Dermoid cysts are benign congenital tumors, which comprise from 0.4 to 0.6 per cent of all intracranial tumors. They are found predominantly in adults but may be diagnosed in younger age groups. Horrax reported two dermoids causing symptoms at the ages of one year and one and a half years. In one case the growth was in the fourth ventricle and caused hydrocephalus and the usual signs of a posterior fossa tumor. In the other case, the tumor was situated in the middle fossa and caused hemiplegia. Later it eroded the temporal bone and was mistaken for a superficial abscess. Dandy gives an abstract of a case in which a huge calcified dermoid cyst gave rise to symptoms at the age of six years. Dermoid cysts date far back in fetal life, grow very slowly and may prove almost asymptomatic. It is due to the slow growth that this tumor is usually found in middle aged groups and young adults. Actually there is no specific age group or sex predilection [*1,2,14,15,22,26,27*].

Dermoids are derived from the deeper layers of the skin, and their cavities are lined with squamous epithelium and contain lanugo hairs, hair follicles, pavement epithelium in which fatty cells float, greasy material and products of sebaceous glands. They have a tendency to rupture more easily than the epidermoid because of their thinner capsule. The size of the dermoid varies in different sites. They frequently attain a relatively large size and undergo cystic degeneration compressing the cerebral hemispheres in all directions. However,

those in the middle fossa often have an hourglass form, one mass protruding upwards into the central portion of the hemisphere and the other extending laterally into the temporal lobe. In most cases the capsule becomes calcified, forming a dense shell-like covering easily demonstrated in roentgenograms. This is often represented by the concentric shadow caused by the calcification in the wall of the cyst and is one of the most valuable diagnostic signs of intracranial dermoids [*11,20,21,23,25,29,30*].

These tumors are most frequently found along the central axis involving the region of the pituitary, pineal gland, the lateral, third and fourth ventricles, and the distal end of the spinal cord. They can occur anywhere on the base of the brain from the anterior perforated space to the foramen magnum. In some instances, as in the cases reported, the cysts rupture spontaneously and spread their contents throughout the cerebrospinal fluid system, thus producing a severe, fatal ventriculitis and leptomeningeal reaction. The spreading lipoid materials, cholesterol crystals, and cellular masses may produce arachnoiditis with a blockage in the flow of cerebrospinal fluid and, thereby, hydrocephalus [*3,4,6–10, 12,13,16,17,19,28,31–33*].

Histologically the dermoid is characterized by ectodermal epidermis plus mesodermal corium with its connective tissue fat cells, sebaceous glands, and hair follicles. The dermoid consists of a fibrous outer layer of connective tissue stroma and an epithelial inner layer. The connective tissue matrix or corium may contain sebaceous glands, hair follicles, fat cells, smooth muscles, elastic fibers and blood vessels. Calcification and bony or cartilagenous connective tissue matrix may be visible roentgenographically [*25,30*].

The predominant signs and symptoms which occur with a ruptured intracranial dermoid are essentially the same as those of an expanding lesion in the brain plus the manifestations of severe aseptic meningitis. Since edema of neighboring brain tissue is common, increased intracranial pressure develops rapidly, with the concurrent danger of herniation of the cerebellar tonsils to the foramen magnum and/or the uncus to the tentorium. Thus the early symptoms, headache and vomiting, are produced. Convulsions, focal or generalized, are common. Headaches, dizziness, drowsiness and mental confusion are non-specific symptoms. One or more of these symptoms are not infrequent in patients with cerebral neoplasm and there is insufficient evidence to indicate whether they are common or more severe in the period immediately preceding the rupture.

The symptoms may be divided into focal and generalized types. The focal neurological symptoms such as paralysis, sensory loss, defective speech, ataxia, cranial nerve palsies and stiffness of the neck as in the cases reported by Scheinker, Miller and others, are related to the site of the tumor. The generalized symptoms include headaches, vomiting, convulsions, psychotic episodes, confusion, mental stupor, disorientation, impairment of memory, and coma. Irregularities in the size and reaction of the pupil and stiffness of the neck are common findings. In fact, because of the pain and stiffness of the neck, the patient described herein was treated over a period of three months for arthritis of the cervical spine.

Varying degrees of calcification in the tumor may be seen in the roentgenograms, though the diagnosis can rarely be made before operation or exposure of the tumor. Albumin and casts are usually found in the urine, and transient hyperglycemia or glycosuria in the absence of diabetes mellitus is not infrequent. This may be due to the cerebral disturbance in the sugar metabolism as a result of the cerebral injury. The white cell count in the peripheral blood is usually elevated—1,200 to 20,000 per cu. mm. is not uncommon. The cerebrospinal fluid pressure is markedly elevated, between 200 to 600 mm. H_2O or more. The cerebrospinal fluid is generally cloudy with bits of necrotic debris; cholesterol crystals may be found in fresh preparations and are easily identified when stained with cresyl violet. A moderate to severe pleocytosis is characteristic (100 to 4,000 cells per cu. mm. is the rule) with elevated protein, normal sugar levels and absence of organisms. The electroencephalographic changes are similar to those which are found with other space occupying lesions.

The differential diagnosis of a ruptured intracranial dermoid is rendered extremely difficult by the similarity of the body's reaction to any form of leptomeningeal irritation, whether it is caused by blood (as in subarachnoid hemorrhage) or pus and necrotic debris (from an infected neoplasm, aneurysm or cerebral abscess). The difficulty is increased when the patient is in a comatose state and

there is no adequate history concerning the onset of coma. In such cases a careful examination of the patient and judicious use of certain laboratory tests are necessary. The laboratory procedures of greatest value are: (1) a thorough study of the cerebrospinal fluid including its pressure, proteins, sugar and chlorides concentrations, cell counts and presence of organisms or cholesterol crystals; (2) examination of the urine; (3) the determination of the nonprotein nitrogen and the sugar content of the blood; (4) roentgenograms of the skull; and (5) electroencephalography. Pneumoencephalography, ventriculography and cerebral angiography are of prime importance in localization of the site of the tumor. The size and reaction of the pupils, the optic discs, the character of respirations, the temperature, pulse rate, and blood pressure must be frequently and carefully observed as these patients almost invariably tend to have herniations of the cerebellar tonsil and uncus.

Immediate surgical intervention is advocated. The study of the eleven cases of ruptured intracranial dermoid reported in the literature (all of which were fatal) has shown that conservative treatment, and hope for the encapsulation of the ruptured dermoid, has proven to be ineffective. Likewise, the use of antibiotics is unrewarding. It is imperative, therefore, that immediate surgical decompression with complete removal of the dermoid should be performed. It is important that the wall of the cyst, which is the only living part of the neoplasm, be completely removed. This must be done to prevent recurrences; simple excavation will not suffice. Frequently, however, the tumor may spread rather extensively along the region of the third ventricle or a portion of the capsule may be intimately associated with such structures as the optic tract or vessels of the circle of Willis. In such situations complete removal is out of the question [17].

SUMMARY

1. A case of ruptured intracranial dermoid cysts with ventriculitis and meningitis occurring in a forty-five year old woman has been described.

2. A survey of all the cases of ruptured intracranial dermoid in the literature proved that the mortality among such patients is extremely high.

3. Late surgical intervention has proved unsatisfactory in all intracranial dermoid cysts, and the importance of early recognition and surgical intervention is greatly stressed. A high degree of suspicion must always be maintained in all cases of meningitis with abnormal intracranial calcification.

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Traumatic Rupture of the Proximal Jejunum

REPORT OF TWO CONTRASTING CASES

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ALMOST challenging aspect of surgical practice is the management of the patient with non-penetrating trauma to the abdomen. Typically, with leakage of upper gastrointestinal fluid into the free peritoneal cavity, a patient will show signs of chemical peritonitis within the first several hours following injury. However, we have recently cared for two patients who showed an interesting contrast in this regard. Surgical exploration is indicated when a diagnosis of injury to the bowel with chemical peritonitis can be made following trauma. However, both of these case reports will serve to emphasize the difficulties in making such a diagnosis when a perforation is high in the jejunum.

A careful history of the injury and of the past medical record, a thorough physical examination, and the necessary laboratory and roentgenographic studies will serve as a foundation for the diagnosis and management of these patients. The mechanisms of injury are important because crushing anterioposterior forces can cause rupture of a hollow viscus. Tangential forces, however, tend to tear the mesenteric attachments and other fixed points within the abdominal cavity. Sudden compression of the abdominal cavity also can cause increased pressure within a hollow viscus with subsequent rupture.

Abdominal pain is an important symptom which should be carefully evaluated. When there is leakage of bile, gastrointestinal fluids, or feces, there is a severe chemical irritation of the peritoneum and pain occurs soon after the injury. However, when there is leakage of air, blood or urine, the peritoneal signs and symptoms occur later since these substances are less irritating initially. Pain also may be due to stretching or pulling on the peritoneum or mesenteric attachments of the intra-abdominal organs, this pain usually being localized and relieved by changes in position. Pain can also be produced by distention of smooth muscle organs, but colicky pain is characteristically seen with spasm of smooth muscle secondary to a distal obstruction. Pain referred to the shoulders and chest is seen frequently with intra-abdominal soiling and subsequent peritoneal irritation along the subdiaphragmatic peritoneal surfaces. Pain in the back and flank is noted with dissection of blood or peritoneal irritation in the retroperitoneal spaces. There are other important points to be included in obtaining the history which are not within the scope of this paper but which at times are important in evaluating the patient with non-penetrating trauma to the abdomen. These are: the presence of previously enlarged or diseased organs within the abdomen which will allow these organs to be injured more easily, history of previous surgery or of known congenital absences of organs. A full or empty bladder at the time of injury and subsequent emesis or voiding and its characteristics are other facts to ascertain.

The initial physical examination should be complete and should be carefully recorded for this is often the basis for subsequent decisions and will serve as a basis for following the patient's subsequent course. Observation should be made as to the patient's level of consciousness and his reactions to the injury. Pulse rate, blood pressure and temperature should be carefully recorded and observed for subsequent changes. After a complete physical examina-

tion, the abdomen should be examined by means of inspection, auscultation and gentle palpation and percussion. The presence of rigidity of the abdominal wall is rather nonspecific in the period immediately after injury, for this can be the result of injury to the muscular wall. Evidence of tenderness, either localized or generalized, is also of importance but should be carefully evaluated. Adynamic ileus frequently accompanies blunt trauma to the abdomen but peristalsis usually resumes its normal activity within several hours unless the intra-abdominal trauma is severe. It should be remembered that some bowel activity is audible even in the presence of generalized peritonitis for a segmental type of ileus can occur as a reaction to localized irritation. The position in which the patient is most comfortable should be determined for much information can be gained from this. Respiratory difficulty due to pain and diaphragmatic irritation frequently are relieved by the upright position. The presence of tenderness or fullness on rectal examination is also important. An enlarging mass in the left upper quadrant of the abdomen may signify an intracapsular rupture of the spleen or a hematoma from frank rupture of the spleen.

Laboratory examinations need not be extensive. Simply a leukocyte count, differential count, a hemoglobin and hematocrit determination will serve as an initial basis for study but should be repeated at frequent intervals. An initial urinalysis should be obtained and also should be repeated as necessary. A serum amylase determination usually is of little value during the initial examination but an elevation later in the patient's course may represent injury to the pancreas, duodenum or severe peritonitis. Roentgenograms of the abdomen should be obtained and should include a flat and upright view and a lateral decubitus view for the presence of free air within the peritoneal cavity. These films also serve to demonstrate fractures of the pelvis, ribs and vertebral bodies and are additionally helpful in outlining the psoas shadows or enlargement of normal organs within the abdomen.

Diagnostic abdominal needle paracentesis is currently being evaluated as an aid in determining the presence of intra-abdominal leakage of blood or gastrointestinal fluid. We have used this method at this hospital but have found that in most cases the indications for surgery were sufficient so that regardless of our findings the subsequent management was unchanged. However, this diagnostic test appears to be associated with little morbidity or complication and if performed carefully can give added information preoperatively. A spinal type needle with a stylet is inserted into the peritoneal cavity through the anterior abdominal wall after aseptic preparation of the skin. Careful aspiration is carried out and the fluid obtained is analyzed both grossly and microscopically, and by chemical determinations if necessary, to determine its content. The presence of blood within the peritoneal cavity can be distinguished from venous blood by a simple microhematocrit determination and comparing the results with the circulating venous hematocrit. Blood within the peritoneum causes a serous reaction and subsequent dilution occurs. The presence of bile can be determined by the usual chemical tests. Microscopic examination for white blood cells and bacteria is also of value. Other diagnostic steps possible in these patients are the passage of a Levin tube to determine the gastric contents, and the passage of a urethral catheter to determine the appearance of the urine and, secondarily, to follow the patient's urinary output.

Williams and Zollinger [4], in 1959, reported 200 cases of abdominal trauma from Ohio State University Hospital. They found that 85 per cent of the conscious patients with nonpenetrating trauma to the abdomen had abdominal tenderness. Abdominal X-ray films were helpful in only 34 per cent of the cases. An elevation of the white blood count was present in 70 per cent of instances but also was elevated in many cases of extra-abdominal trauma; therefore, it is of little positive value. Needle paracentesis, however, was valuable and was found to be accurate in 79 per cent. It was stated in this article that delay in diagnosis and treatment was not as responsible for an appreciable increase in the mortality as was the presence of multiple injuries.

Giddings and McDaniel [3] studied 1,168 cases of wounds of the jejunum and ileum during World War II and found that six were due to non-penetrating trauma which had occurred during vehicle accidents. Traumatic rupture of the bowel had occurred in these cases. The over-all mortality of perforation of the small intestine was 29.4 per cent when a single perforation was noted but increased

with multiple injuries. Bowers [1] reported that the mortality for small bowel damage during the Korean conflict was reduced to 13 per cent. Bowers also has stated that the development of peritoneal infection secondary to intra-abdominal trauma is partly a quantitative matter and the mortality depends primarily on the following four factors: the size and number of perforations, the level of the perforations, the time intervening before therapy, and the general and local state of resistance of the host. Bowers and Bergh have shown experimentally that, in the dog, perforations of the stomach which are left unsutured are followed by a mortality of 7 per cent in the empty stomach as compared to 87 per cent in the full stomach. Perforations of the duodenum were accompanied by a mortality of 81 per cent, of the jejunum by 44 per cent, and of the ileum by 100 per cent. In comparison, perforations of the cecum and left colon were accompanied by a mortality of 23 per cent and of the rectum by 12 per cent. Thus, acidity and volume of the spilled materials, as well as the viability of the bacteria, are important in determining the extent of peritonitis and the associated mortality. The age and general resistance of the host also are important factors but are difficult to measure objectively.

CASE REPORTS

CASE 1. A fifty-five year old white man was admitted to this hospital one hour after an aircraft accident. The patient was riding in a bucket-type seat and had a safety belt loosely applied across his mid-abdomen. The vehicle crashed, landed on its undercarriage, then bounced high into the air and landed on its side. The patient incurred both severe blunt trauma to the buttocks and ischial tuberosities and severe blunt trauma to the lower abdominal wall in an anterioposterior direction compressing his abdominal viscera against his vertebral bodies. He was given intravenous meparadine at the scene of the accident and was brought by ambulance to the hospital for further care.

His past medical history was within normal limits. Initial physical examination revealed a temperature of 98.2°F., a pulse rate of 88 and a blood pressure of 120/70 mm. Hg in both upper extremities. The patient was alert and cooperative, but he complained of severe lower abdominal pain which was greatly aggravated by any movement of the lower extremities or by coughing. General physical examination was within normal limits except for severe muscle spasm of the lower recti muscles with great difficulty in voluntary relaxation. The upper abdominal musculature was rather soft and palpation could be performed over both upper quadrants. Bowel sounds were present on admission but were hypoactive. Rectal examination revealed normal stool in the ampulla and no tenderness was noted. The external genitalia were normal, although some abrasions and early contusions were noted over both ischial tuberosities. Neurologic examination was within normal limits.

The admission laboratory data revealed a leukocyte count of 7,400 per cu. mm. with 76 per cent neutrophils and 22 per cent lymphocytes. The hemoglobin was 12 gm. per cent and the hematocrit, 40 per cent. A urine specimen revealed clear, straw-colored, acid urine with a trace of albumin present and 10 to 12 white blood cells per high powered field. Roentgenograms of the chest and abdomen, including a flat and upright film and a lateral decubitus film, failed to reveal evidence of free air or any significant abnormalities. An electrocardiogram taken on the day of admission revealed a mild sinus tachycardia but was otherwise normal.

Shortly after the initial physical examination, a Foley catheter was passed into the bladder and clear urine was obtained. This was left in place and intravenous dextrose in water was administered slowly to maintain adequate fluid intake. A rubber Levin tube was passed into the stomach revealing normal bile-stained gastric fluid. The patient continued to complain of severe pain with any motion of the lower abdominal wall and some subcutaneous edema and discoloration was noted over the lower abdomen. Six hours following admission, bowel sounds had returned to normal quality; however, the patient continued to complain of severe pain. The pulse rate continued to be 88 and the blood pressure was unchanged. Approximately six hours after admission, some discoloration was noted in the gastric aspiration and a guaiac test was performed which was positive for occult blood. This never became a gross finding, however. A repeat leukocyte count at this time revealed a total count of 8,100 per cu. mm. with an essentially normal differential. The patient was followed up carefully, and the abdominal tenderness was somewhat relieved by the assumption of a semi-Fowler's position with the hips flexed. The temperature, pulse and leukocyte count remained stable through the first twenty-four hours after admission, and bowel sounds were active and normal during this period of time. Continuous gastrointestinal decompression by means of the Levin tube had been used and, because of the patient's response to this treatment and apparent improvement, the Levin tube was removed twenty-four hours after admission and the patient was

given a liquid diet. One hour following the ingestion of beef broth, he vomited but noted no aggravation of pain.

Excretory urograms and a cystogram revealed no gross evidence of trauma to the urinary tract. However, within thirty-six hours of the injury, the urine was grossly bloody and it was believed that the patient had received severe trauma to the abdominal wall with a contusion of the urinary bladder which would explain these findings. For this reason, the urinary catheter was left in place and a liquid diet was again encouraged. Findings on rectal examination and abdominal palpation remained unchanged. The patient had a bout of severe tachycardia with a pulse rate of 140 and a drop of blood pressure to a level of 100/80 mm. Hg thirty-six hours following admission. At this time the oral temperature was 100°F., the pulse was 92, and a leukocyte count revealed a total of 5,800 per cu. mm. with 75 per cent neutrophils. Twenty per cent of these neutrophils were of the band form. A hematocrit reading at that time was 54 per cent which was thought to represent hemoconcentration due to extravasation of fluid into the area of contusion. The patient was given oxygen and intravenous saline and had responded within one hour. Sixty hours following the trauma, the patient again had a bout of severe tachycardia with a pulse rate of 160. He had a marked drop in his systolic and diastolic blood pressure and was again treated with oxygen and was placed in Trendelenburg position. Throughout his entire course, his abdomen had remained soft in the upper portion and bowel sounds had been normal. Rectal examinations had also been normal until this time. No jaundice had been noted. Repeat roentgenograms of the abdomen again failed to reveal evidence of free fluid or air within the abdominal cavity and no ileus was seen. A No. 18 needle with a stylet was introduced into the left lower quadrant of the abdomen after sterile preparation of the skin and 4 cc. of cloudy, yellow-brown fluid was obtained. This was alkaline and, on Gram's smear, revealed innumerable gram-positive and gram-negative organisms with many leukocytes present. The patient was given dextrose in water with norepinephrine and dextran solution. An exploratory laparotomy was performed at this time.

The findings at the time of surgery were those of generalized peritonitis. There were five separate perforations of the jejunum, all occurring on the antemesenteric border of the upper jejunum, without any evidence of an attempt at closure by the greater omentum or adjacent organs. Because of the generalized peritonitis and state of shock of the patient, complete exploration of the abdomen could not be performed. The perforations were closed with two layers of interrupted silk sutures and the abdomen was closed with stainless steel wire retention sutures. Penrose drains were placed through separate stab wounds into each lower quadrant of the peritoneal cavity. Penicillin and streptomycin were placed in the peritoneal cavity and intravenous penicillin and streptomycin were administered. The patient had a stormy postoperative course, requiring the administration of hydrocortisone intravenously and norepinephrine in an attempt to stabilize his blood pressure. He was given 1,000 cc. of whole blood during the operative procedure and a total of 2,500 cc. of blood during his hospital course. He developed a severe bronchopneumonia with pleural effusion bilaterally which required thoracentesis on two occasions. He also had a single episode of pulmonary edema which was thought to be secondary to sodium retention from the intravenous cortisone therapy. Severe mental deterioration occurred accompanied by hallucinations and periods of unconsciousness. His course was one of gradual decline and was complicated by infection in the wound and bronchopneumonia. Electrolyte studies remained within normal limits during this time. Because of shock and obstruction to the tracheobronchial tree by thick secretions, a tracheotomy was performed on the twelfth postoperative day and the patient quietly died after sixteen days of hospitalization.

Postmortem examination substantiated the presence of severe bilateral bronchopneumonia with pleural effusion and of resolving generalized peritonitis with infection in the wound. An additional finding was that of a large infarct replacing approximately half of the right lobe of the liver with central necrosis and necrotic debris. This latter finding was thought to be due to the original trauma and certainly contributed to the severity of the peritonitis and the patient's subsequent death. This latter finding also explains the mental status for with absorption of toxic materials this is well documented. The contusion of the lower abdominal wall with severe muscle damage was also noted at the time of autopsy. All the jejunal perforations were well healed.

CASE II. An eighteen year old boy was admitted to this hospital four hours following blunt trauma to the mid-abdomen. He was running across a field when he suddenly ran into a horizontal guard rail which caught him across the mid-abdomen with subsequent anterioposterior compression of the intra-abdominal contents. The patient did not lose consciousness and stated that he felt well for approximately ten minutes following the injury but then noted severe upper abdominal distress and weakness. His complaints gradually became aggravated to the point that he was doubled up and complaining of severe pain and weakness at the time of his admission to the hospital. Initial

examination revealed an oral temperature of 99°F., a pulse of 84 and a blood pressure of 140/92 mm. Hg. He was alert and cooperative but was in severe distress from the abdominal pain. He assumed a position with the back and hips flexed and was lying on his right side for relief of the pain. General physical examination was within normal limits with the exception of the abdominal findings which were mainly those of severe, generalized muscular rigidity and tenderness to palpation over all of the abdominal quadrants. Bowel sounds were hypoactive although present. Rectal examination was interpreted as normal. No external evidence of trauma was seen. Neurologic examination was within normal limits.

The initial leukocyte count was 24,700 per cu. mm. with 81 per cent neutrophils. The hematocrit was 46 per cent. A voided urine specimen revealed straw-colored urine with a specific gravity of 1.020 and was otherwise within normal limits. Serum amylase was also within normal limits. White blood count four hours after admission was 28,000 per cu. mm. with a rise in the hematocrit to 50 per cent. A roentgenographic study, including flat and upright films and a lateral decubitus film, revealed no abnormalities. No free air was demonstrated.

The patient was given intravenous fluids on admission and was followed for approximately four hours during which time his pulse rate gradually rose to 96, his blood pressure remained stable and his oral temperature rose to 100.8°F. Despite adequate fluid intake, he appeared slightly dehydrated. Because of the increasing severity of the symptoms, despite the normal bowel activity and normal rectal examination, it was believed that severe intra-abdominal trauma had occurred. A needle paracentesis was performed in the right lower quadrant of the abdomen after preparation of the skin. Straw-colored fluid was obtained which revealed the presence of numerous white blood cells but no significant bacteria. The fluid was not bloody. The patient was taken to the operating room ten hours after the injury and an exploratory laparotomy was performed.

Upon entering the peritoneal cavity, 500 cc. of brownish green fluid were noted. A complete severance of the jejunum had occurred at approximately 18 inches below the ligament of Treitz. The tear extended approximately 2 inches into the mesentery of the small bowel. No bleeding from either torn end of the jejunum was noted but obvious fluid contamination of the peritoneal cavity, including the true pelvis, had occurred. Thorough exploration of the abdomen failed to reveal other abnormalities. By gentle suction the fluid was removed from the peritoneal cavity, the torn ends of the jejunum were resected and an end-to-end anastomosis was performed utilizing two layers of interrupted silk sutures. The tear in the mesentery was also repaired. Because of the generalized peritoneal contamination, penicillin and streptomycin were placed in the abdominal cavity and wire retention sutures were used in addition to layer closure of the abdominal wall. The patient had an uneventful postoperative course. The wound healed primarily and oral feedings were begun on the third postoperative day. His subsequent postoperative course was uneventful and he was returned to duty status twenty-five days following admission to the hospital.

COMMENTS

These cases serve to demonstrate several important points, one of the most important of which is that with perforation of the upper small bowel, free air cannot be observed by the usual roentgenographic means in 70 per cent of the patients. Free air could not be demonstrated in either of these patients, yet multiple perforations had been present in the one and a complete transection had occurred in the other. This can best be explained by the fact that free air is not normally present in the small bowel of the adult but is in the stomach and colon. The presence of audible bowel activity in the presence of severe peritoneal contamination is also worthy of some discussion for it is stated that adynamic ileus is occasionally associated with a silent abdomen. In both of these patients, bowel activity was audible, serving only to emphasize that adynamic ileus can be segmental and bowel activity can be concurrently present in other segments of the intestinal tract. This appears to be more evident with perforations of the upper intestinal tract than with those of the lower ileum and colon.

Case 1 has several features which are worthy of discussion, namely, the patient's lack of fever, leukocyte response or pulse rate elevation which is expected in cases of severe peritonitis. Not until late in his course did he show signs of shock or of tachycardia and his bowel activity and rectal examination remained essentially normal up to the time of surgery. His early symptoms were undoubtedly due to the muscle contusion of his lower abdominal musculature, but subsequent signs of peritonitis were certainly lacking. The only evidence of a leukocyte response was the increased proportion of band forms of polymorphonuclear leukocytes, which may be accounted for by the overwhelming inflammation. The age

of this patient may be another factor explaining his atypical response. His failure to show the usual response to a perforation of the bowel may in some way be explained by the fact that the upper jejunal contents are in the normal pH range since the contents are both gastric and duodenal and are mixed acid and alkaline in nature. Thus, with neutral solution of known low toxicity, the peritoneal reaction may have been delayed. The relatively low bacterial content of the upper jejunum may also contribute to the lack of the usual peritoneal irritation associated with bowel perforations.

These two cases serve to point out that spillage of upper jejunal contents may not give rise to the usual signs of perforation of the gastrointestinal tract and that the host's response also is quite variable.

SUMMARY*

1. The careful evaluation of the patient with blunt trauma to the abdomen includes a complete history, careful physical examination and necessary laboratory and roentgenographic studies. Certain important factors in each of these categories are discussed and emphasized.

2. The case of a patient who received blunt, non-penetrating trauma of the abdomen with five separate perforations of the upper jejunum along with a traumatic infarct to the liver and severe contusion of the abdominal wall without diagnostic signs indicating the necessity for surgical intervention is reported.

3. A case report of similar trauma to the abdomen in which a complete transection of the jejunum occurred with an associated tear of the mesentery, but with findings which made exploration mandatory, is presented.

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* After writing this paper we treated a third patient with complete rupture of the upper jejunum associated with non-penetrating abdominal trauma. A twenty year old man was injured in a motor scooter accident sustaining multiple fractures of the extremities and an open fracture of the left iliac crest. Abdominal exploration was performed eight hours after injury because of increasing evidence of peritoneal irritation and blood loss. A needle paracentesis revealed bloody fluid containing food particles within the abdomen. Debridement and anastomosis were performed twelve inches from the ligament of Treitz. An associated injury was a severe contusion of the sigmoid colon which was treated by a temporary exteriorizing colostomy. His subsequent hospitalization has been satisfactory.

Postoperative Tetanus

A CASE REPORT WITH DISCUSSION OF THE DISEASE

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TETANUS is rather uncommon in the eastern section of the country, although in the entire United States approximately 500 cases are reported annually. However, tetanus after aseptic surgery is rare anywhere, and such a case is the purpose of this presentation.

The active agent is Clostridium tetani, a gram-positive organism which commonly gains entrance into the body through puncture wounds of the extremities, compound fractures, burns, and less commonly, through insect bites, needle wounds and the uterus.

CASE REPORT

Patient N. B. (No. A 21563), a thirty-seven year old Italian woman, was admitted to the Pennsylvania Hospital in October 1957, with a semi-acute condition within the abdomen, the nature of which was not clear. Gastrointestinal roentgenograms and sigmoidoscopy were within normal limits. She had had clinical evidence of endometriosis in the past, and in July 1957, she had used hot water bottles to relieve abdominal pains, and thereby sustained first and second degree burns. On October 15, 1957, laparotomy was performed. An endometrial cyst was found and removed. Appendectomy was also performed and the stump inverted.

Postoperatively, her course was smooth until the seventh day, when she noted the onset of pain in the masseter muscles and had some difficulty in mastication. On the morning of the eighth postoperative day (October 24), she had the full-blown picture of tetanus, characterized by trismus, opisthotonos, risus sardonicus and hyperreflexia. A test dose of sodium pentothal was injected intravenously; this produced relaxation generally, but not in the masseter muscles. A spinal tap revealed normal findings, thus excluding meningitis, and examination of the neck revealed no infection. Laboratory studies revealed a white blood count of 10,700 per cu. mm., neutrocytes 87 per cent and hemoglobin 12 gm. per cent. Subsequently, smear and cultures of stools were negative for Cl. tetani. Thus, a tetanus regimen was instituted which consisted of a dark quiet room, tetanus antitoxin given intravenously after a test dose, penicillin 500,000 units administered every four hours, sedation, muscle relaxants, indwelling catheter, bite blocks and maintenance of an adequate airway. The following morning tracheotomy was performed as secretions and pharyngeal spasm had become a problem. The test dose of tetanus antitoxin produced a 1 cm. wheal; therefore, cortisone and Benadryl,® 25 mg. of each four times daily, were given to control allergic reaction. These were continued throughout the period of tetanus antitoxin therapy. It was interesting to note that hives would develop if the tetanus antitoxin was given too rapidly, necessitating larger doses of cortisone and Benadryl. There was a very critical balance of these agents.

Sedation consisted of barbiturates, Flexin® for milder spasms and tubocurare or Anectine® for convulsions. These were quite effective but, of course, required careful supervision and, at times, mechanically controlled respiration.

Her course was characterized by toxic symptoms (temperature as high as 105.4°F. on the fifth day) and exacerbations which suggested the continued liberation of tetanus toxins On the sixteenth day bite blocks were still needed. Marked rigidity and dysphagia persisted. (Fig. 1.) By the twenty-sixth day after onset, these subsided and she could open her mouth 1.5 cm. from gum to gum (edentulous). The tracheotomy tube was removed. Nutrition, fluids and electrolytes were maintained by either the intravenous route or nasogastric tube during this period. She remained well oriented and was discharged on the thirty-first postoperative day. Her course has been uneventful since discharge except for some anxiety symptoms, chiefly a feeling of choking which proved to be non-organic on bronchoscopy.

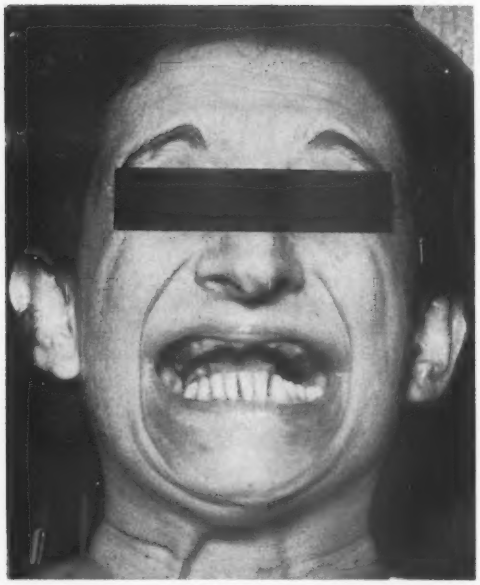

FIG. 1. This photograph was taken on the twenty-third day after onset of tetanus.

COMMENTS

This case presents several interesting points. First, there is the obscure source of entry of the organism. No recent history of insect bites or surface wounds of any kind was noted, except for first and second degree burns of the abdomen three months previously. A possible source of contamination is the abdominal wound from appendectomy. Cl. tetani has been reported in human intestines but none was found on several examinations of stools. Other possible sources are dust in the air and catgut sutures.

In February and March 1957, there were five cases of tetanus with two deaths at North Staffordshire Royal Infirmary [7,8]. Tetanus spores were found in the operating suite, in dust, debris, wall plaster, on uncovered light bulbs and on a surgeon's glove, the presumable source being animal hair used in the plaster for binder. The suite was permanently closed and a new one built. Since no other cases have occurred at the Pennsylvania Hospital, such an exhaustive study as to source has not been thought essential.

Another interesting problem was the control of this patient's allergic reaction with cortisone and Benadryl which made possible large, continued doses of tetanus antitoxin. This was thought advisable since the abdominal wound was presumed to be the source of infection and thus the possible seat of unlimited spore formation. Consequently, she received a total dose of 1,302,500 units of tetanus antitoxin, the largest dosage we have found recorded.

TREATMENT

We believe that treatment of postoperative tetanus should be as follows:

1. Eliminate the source of toxins by debridement or excision of site of infection if possible.
2. Neutralize the circulating toxins with antitoxins administered intravenously or intramuscularly.
3. Maintain a clear airway.
4. Maintain adequate sedation and muscular relaxation with the following:
   a. Barbiturates.
   b. Paraldehyde or Flexin for mild spasms.
   c. Tubocurare or Anectine for convulsions, administered under supervision of anesthesiologist.
5. Nutrition and electrolyte balance should be maintained.
   a. Intravenously if ileus is present.
   b. Nasogastric tube feedings, small and frequent to minimize possibility of aspiration.
   c. Gastrostomy, preferred by some doctors.
6. Antibiotics should be given for prevention of secondary infections and for possible effect on clostridium organisms.
7. Diligent nursing care twenty-four hours each day is absolutely essential.

PROGNOSIS

The prognosis varies with the severity of the disease, but in all cases should be guarded. In general, the shorter the incubation period, the more severe the disease and hence, the higher the mortality. Two of the five patients reported on by physicians of the North Staffordshire Royal Infirmary survived. In the group of 558 cases reported from Charity Hospital, New Orleans, during the period 1943 to 1956, the incubation period was 40 per cent longer for survivors than for those who died. The mortality rate for this group was 30 per

cent. The rate is lower in children and higher in those past the age of fifty years (50 per cent) [2].

PROPHYLAXIS

By far the best way to prevent this disease is by active immunization using toxoid 0.5 to 1 cc. administered intramuscularly or subcutaneously at one- and two-month intervals initially, with booster doses after one and five years, and after any accident when there is a possibility of tetanus.

The safety and efficiency of this program were well demonstrated in the United States Army during World War II when only fifteen cases of tetanus occurred in over 2,400,000 wounded men.

For those not immunized 1,500 units of tetanus antitoxin has been the standard dosage in most institutions. However, this has been insufficient in a few instances reported. One patient reported on by Creech, Glover and Ochsner [2] had received 1,500 units at the time of injury fourteen days before the onset of tetanus. This patient had received a complete course of tetanus toxoid and another patient had received a partial course, but neither received a booster at the time of injury.

Two local cases of tetanus are on record occurring after prophylactic antitoxin. Tetanus developed in a seven year old girl twelve days after a splinter wound of the leg, even though she received 1,500 units of tetanus antitoxin the day of injury. She subsequently recovered. A second case occurred in a young man eighteen days after he had abrasions. He received 1,500 units of tetanus antitoxin the day of injury. He subsequently died.

We found no reported cases after 3,000 or more units were given at the time of injury. Thus, for wounds in an unimmunized person in whom contamination by tetanus organisms is likely, it would be advisable to give a minimum of 3,000 units of tetanus antitoxin.

SUMMARY

A case of tetanus occurring during the postoperative period is presented. The source of the organism remains unknown. The cause, treatment, prognosis and prophylaxis of tetanus are discussed. The mortality rate remains high, and there is as yet no specific therapy. We would like, therefore, to emphasize the importance of active immunization of everyone regardless of age. Prevention, especially by active immunization, is highly effective in contrast to treatment of the disease.

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Hemangiopericytoma of the Ligamentum Teres of the Liver

REPORT OF A CASE

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THE intra-abdominal region is known to be the site of an almost innumerable variety of tumors arising from the various organs and tissues composing it. Many of them have attained a huge and even fantastic size. Delamater reported a lipoma which he claimed weighed 275 pounds when the patient died [1]. We recently treated a patient with a large intra-peritoneal tumor that proved to be of special interest because it was a hemangiopericytoma that arose in the ligamentum teres of the liver. The round ligament of the liver must be a very unusual site for the origin of a tumor of any kind. Edmondson could find no reports of any in the literature. He states that only one tumor of unidentified nature is recorded in the files of the Armed Forces Institute of Pathology as having arisen in the ligamentum teres [3]. The hemangiopericytoma is a vascular tumor featuring pericytes which are the peculiar cells that have contractile powers and are found on the outer surface of capillaries [5,6]. Hemangiopericytomas may arise anywhere that capillaries are found. A considerable number of them within the abdominal cavity have been recorded. In addition to those arising in the gastrointestinal and urogenital tracts, the majority within the abdominal cavity have arisen from its supportive tissues. Up to the end of 1958, a total of 307 cases of hemangiopericytoma have been recorded in the Surgical Pathology Laboratory of Columbia University. Of these, thirty arose in the retroperitoneum, three in the mesentery, three in the omentum, one in the gastrocolic ligament and one in the gastrohepatic ligament. Two were primary in the liver and, in addition, there were five metastases in the liver and four in the retroperitoneum from primary hemangiopericytomas elsewhere.

The hemangiopericytoma is an exasperating tumor for the pathologist since it is often impossible to predict from the histopathology whether it will be benign or malignant. For example, a hemangiopericytoma of the omentum reported by Stout and Cassel [7] was known to have been present for over sixty years in the omentum of a man ninety-two years old and never metastasized or spread by invasion. It was histologically identical to one in an eleven year old boy (Case 21) who had an inoperable retroperitoneal tumor which eventually metastasized to the skull and femur resulting in his death approximately ten years later [5].

The chances that a hemangiopericytoma of the retroperitoneum will metastasize are about one in four [6].

The hemangiopericytoma shares with several other fibrous tumors the peculiar attribute of occasionally being responsible for hyperinsulinism with hypoglycemia in the absence of any islet cell tumors or liver pathology. One of us has seen two such cases, one reported by Howard and Davis [4] and the other by Dockerty [2] (although not recognized by him as a hemangiopericytoma).

This case is also of interest because it gave rise to physical signs that made it seem as if the great abdominal swelling and varicosities were due not to a neoplasm but to some disturbance of the portocaval circulation and

FIG. 1. Gastrointestinal series disclosing situs inversus, general abdominal haziness and displacement of the intestines suggesting an intra-abdominal mass.

FIG. 2. Large vascular, firm, encapsulated and slightly nodular tumor after its delivery from the abdomen. The tumor is supported by the assistant's hand and its posterior vascular pedicle is still intact. (W = abdominal walls, S = inverted stomach and omentum, R = retractor placed over lesser right hepatic lobe L = major left hepatic lobe.)

hepatosplenomegaly, concomitant with situs inversus. For these reasons we believe this case is worth recording.

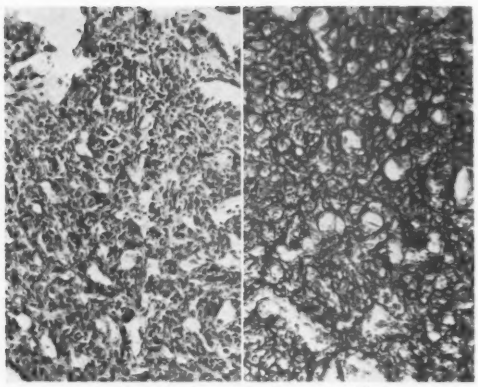
CASE REPORT

C. N. (A 1690), a forty-one year old white man, was admitted to the East Orange Veterans Administration Hospital with huge epigastric varicose veins that had been evident for at least two years. There were also varices on the lower extremities which were more marked on the left side. He complained of epigastric discomfort, anorexia, asthenia, increased diaphoresis and loss of 20 pounds in weight. Five years before he had had a left splenectomy with ligations and a right thyroid lobectomy for adenoma.

Physical Examination. Cholst's sign (dependency of the right testis) was positive. There were marked mid-epigastric varicosities extending to the xyphoid region where an intense postsystolic fremitus and murmur were noted. There were also reinforced basal cardiac tones. The current in these varices was upward while the current was downward in the varices of the anterosuperior thighs and lower abdominal and inguinal regions. There were moderately developed external hemorrhoids. A hard non-tender intra-abdominal mass was palpated in the upper abdomen extending slightly below the transverse umbilical line. This mass gave the impression of a greatly enlarged liver and spleen. The thoracic findings were interpreted as situs inversus.

The rectum-tongue circulation time was 70 seconds using ether. Sedimentation rate was 52 mm. per hour and prothrombin time 15 seconds. The remainder of the routine laboratory tests and a battery of blood chemistry tests were within normal limits. Intravenous pyelography was normal and chest roentgenography confirmed the situs inversus. A gastrointestinal series also showed situs inversus, a small esophageal hiatus hernia, hypomobility of the gastrointestinal canal, a general abdominal haziness and displacement of the intestines suggesting an intra-abdominal mass. (Fig. 1.) There were occasional elevations of temperature to a maximum of 99.4°F.

There were numerous speculations concerning the nature of the abdominal mass and/or the possible splenohepatomegaly. The most favored was Cruveilhier-Baumgarten's pseudocirrhosis with congenital obliteration of the suprahepatic veins followed by typically localized huge umbilicoxyphoid varicosities. This particular "portacaval" collateral circle was considered to have a caval



3A 3B

FIG. 3. A, the hematoxylin and eosin stain shows the marked vascularity of the tumor with the tumor cells tightly packed in around the capillaries that are lined with normal endothelial cells. B, the silver reticulin stain shows that the tumor cells lie outside of the capillary reticulin sheath and that each tumor cell is wrapped with a reticulin fiber.

"run off" represented by unobliterated hepatic ductus venosus thus explaining the absence of serious portal hypertensive phenomena, hypersplenism and normal hepatic function tests. The minimal degree of "cava-caval" collaterals below was assumed to be due to mild caval compression and a downward-pulling effect exercised by the enlarged and inverted hypochondriac organs.

Operation. On February 28, 1959 exploratory laparotomy revealed the anticipated situs inversus but otherwise the liver, spleen and inverted stomach were normal. There was an anomaly of the common hepatic artery for the right hepatic, gastroduodenal and left gastric all originated from a short common pedicle. The dominant lesion was a large, firm, vascular, encapsulated and slightly nodular tumor that originated within the round ligament of the liver and considered at that time an arteriovenous hemangioma. (Fig. 2.) Its anterior pole appeared to infiltrate the anterior abdominal wall. With an incision that avoided the varicose region and kept outside of the large vessels on the surface of the tumor, it was mobilized and excised. After removal it weighed 3 kg. The posterior vascular pedicle was represented by numerous large veins and a couple of arteries that belonged to the round ligament. These vessels extended as unobliterated umbilical trunks into the falciform ligament above the liver and into the ductus venosus below it between the lesser right lobe of the inverted organ and the quadrate and caudate lobes. Anteriorly, the blood supply was represented by large and numerous varices in the mid- supra-umbilical and, to a lesser degree, the mid- infra-umbilical region of the linea alba where a postnatal umbilical ligament had not formed. Because the vascular supply was of such unusual character and morphology, the tumor may have been congenital. The peritoneum formed the capsule of the tumor coming anteriorly from ventral parietal peritoneum above and below the tumor's adherence to the abdominal wall. During the procedure the patient received 1,000 ml. of blood by transfusion.

Postoperative Course. There was an early phlebothrombosis involving the residual epigastric varices. This soon resolved together with the disappearance of all intra-abdominal tumefaction. Four months after operation the patient stated that he was well and felt better than he had in years.

Patbological Examination. Gross: The specimen consisted of a large roughly ovoid irregularly lobulated mass weighing 2,960 gm. and measuring 23 by 22 by 14 cm. Most of the surface was covered by a fairly smooth shiny gray-tan membrane underneath which was a complex network of tortuous dilated blood vessels measuring up to 2 cm. in diameter. The cut surface suggested lobulation with foci of yellowish, somewhat gelatinous material representing necrosis. Many vascular foci were scattered throughout all parts of the tumor.

Microscopic: Sections made from four different areas showed a comparable picture throughout except for foci of necrosis. The unit of growth is represented by a capillary lined by endothelial cells and furnished with a fine reticulin sheath demonstrated by a Laidlaw silver reticulin stain. Outside of this sheath and packed in about it are the rounded and slightly elongated tumor cells most of which are surrounded by fine reticulin fibers. The picture varied from field to field because the cells and capillaries grow in a haphazard fashion in complete disorder. The relationship of cells to capillaries was everywhere maintained: it was the characteristic picture of hemangiopericytoma. Mitoses are rare averaging about one in twenty high power fields. (Fig. 3A and B.)

SUMMARY

An unusual case of hemangiopericytoma of the ligamentum teres of the liver in a patient with situs inversus and puzzling clinical picture is reported. Primary tumors of the round ligament of the liver must be very rare for we could find a report of only one other case.

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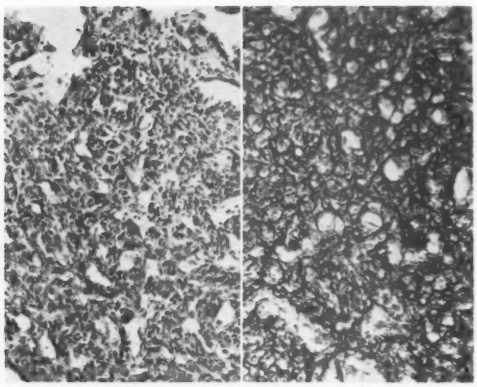

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Acute Diverticulitis of the Ascending Colon

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ACUTE inflammation in a solitary diverticulum of the ascending colon is a relatively uncommon lesion, there being approximately twenty-five such cases reported in the literature [1–5]. Acute cecal diverticulitis, however, occurs more frequently, and somewhat over 200 case reports have appeared to date. In 1953 Vaughn and Mansete [6] made a plea for differentiation between diverticulitis of the cecum and diverticulitis of the ascending colon. They stated that not only was there an anatomic difference, but that in cecal diverticulitis the signs and symptoms bear a greater resemblance to acute appendicitis than in diverticulitis of the ascending colon. Clinically, this has not been our experience, and in reviewing the other case reports in the literature, there does not seem to be a great deal of difference in the symptoms and findings between lesions at either location. Both lesions simulate the clinical picture of appendicitis, and this has been the preoperative diagnosis in the vast majority of cases. Lack of familiarity with this entity in the presence of a normal appendix and cecum at operation may lead to overlooking a lesion higher in the ascending colon.

A few symptoms and factors may be kept in mind in an attempt to make a correct preoperative diagnosis more frequently. The average age of the patients in several of the larger series is about forty-one years. There is no significant sex difference. There is usually generalized or right-sided abdominal pain localizing to the right lower quadrant, but the symptoms are usually of longer duration than with appendicitis. One striking factor is the absence of nausea and vomiting in over 90 per cent of the patients. This is consistent with the frequent absence of nausea and vomiting in diverticulitis of the descending colon, and is perhaps the one important clue which should raise one's index of suspicion.

Treatment of this disease after discovery at laparotomy often poses a problem. The differential diagnosis and choice of procedure are important in minimizing risk to the patient and yet adequately treating the disease. In many cases the localized inflammatory mass resembles a perforating carcinoma. Except for appendicitis, the latter is the most frequent lesion of the cecum and ascending colon. Other conditions which must be considered in the differential diagnosis are tuberculosis and actinomycosis. Theoretically the treatment of choice for diverticulitis of the ascending colon is either simple inversion of the diverticulum with a purse-string suture, local excision and closure of the colon, or simple drainage. Because of the frequent inability to differentiate the diverticular mass from malignancy, the more radical procedure of right colectomy has usually been performed. It should be emphasized, however, that each case must be individualized. If inversion or local resection is possible, concomitant removal of the normal appendix does not seem to add any morbidity to the procedure.

CASE REPORTS

CASE 1. R. C., a forty year old white man, was admitted to the Lankenau Hospital on January 19, 1956, with a forty-eight-hour history of right-sided abdominal pain which became localized to the right lower quadrant. There was no nausea or vomiting. Temperature was 103°F. On examination, the abdomen of the patient was tender with involuntary guarding over McBurney's point. The white blood count was 19,000 per cu. mm. with 82 per cent polymorphonuclear leukocytes. A preoperative diagnosis of acute appendicitis was made.

At operation a granulomatous mass measuring 7 cm. was found on the posterior aspect of the ascending colon just above the cecum. Because

FIG. 1. Low power view of lower portion of diverticulum penetrating outer muscular layer (at right), below which is seen necrosis and hemorrhage in the pericolic tissues.

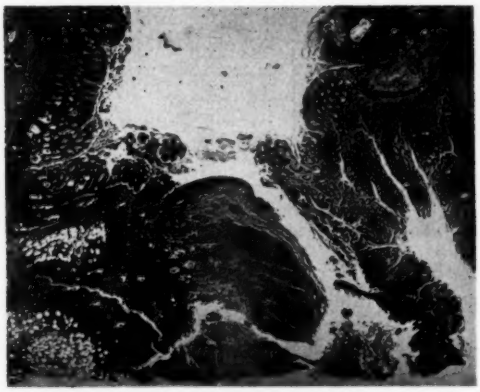

FIG. 2. Low power view of the base of the diverticulum showing necrosis, hemorrhage and perforation into serosal fat.

tumor could not be ruled out, a right colectomy was performed. The patient was discharged well on the thirteenth postoperative day, and has remained asymptomatic since. The pathologic report was perforated diverticulum with abscess.

CASE II. N. A., a twenty-nine year old white woman, was admitted to the Lankenau Hospital on September 4, 1957, with a twenty-four-hour history of generalized abdominal pain which became localized to the right mid-epigastrium. There was no nausea or vomiting. Temperature was 100°F. Abdominal examination revealed tenderness and guarding on the right side. The white blood count was 11,000 per cu. mm. with 72 per cent polymorphonuclear leukocytes. A preoperative diagnosis of a high-lying acute appendicitis was made.

At operation a mass measuring 2 cm. was palpated in the mid-ascending colon. This was suspected to be a tumor of the colon, and consequently a right colectomy was performed. The patient was discharged well on the seventh postoperative day, and has remained asymptomatic since. The pathologic report was acute diverticulitis of the ascending colon. (Fig. 1.)

CASE III. O. F., a seventy-six year old white man, was admitted to the Lankenau Hospital on January 20, 1958, with a three-day history of lower abdominal pain which had become localized to the right lower quadrant. There was no nausea or vomiting. Temperature was 98.6°F. Abdominal examination revealed tenderness and guarding over McBurney's point. The white blood count was 14,900 per cu. mm. with 81 per cent polymorphonuclear leukocytes. A preoperative diagnosis of acute appendicitis was made.

At operation a mass measuring 2 to 3 cm. was found in the mid-ascending colon. Careful dissection revealed this to be a diverticulum with a fecolith impacted at its base. In further freeing of the diverticulum the fecolith was displaced back into the lumen of the large bowel. The diverticulum, being thin-walled, was inverted and oversewn into the ascending colon with a purse-string suture. The appendix, which was normal, was then removed. The patient was discharged well on the ninth postoperative day, and has remained asymptomatic since.

CASE IV. J. F., a forty-five year old white man, was admitted to the Lankenau Hospital on November 19, 1958, with a three-day history of generalized abdominal pain which had become localized to the right lower quadrant. The patient was anorexic, but there was no nausea or vomiting. Temperature was 99°F. Abdominal examination revealed tenderness with guarding over McBurney's point. The white blood count was 13,600 per cu. mm. with 75 per cent polymorphonuclear leukocytes. A preoperative diagnosis of acute appendicitis was made.

At operation a tumor mass measuring 6 cm. was found on the lateral wall of the mid-portion of the ascending colon. The lesion was suspected to be a diverticular mass, but as malignancy could not be excluded, a right colectomy was performed. The patient was discharged well on the thirteenth postoperative day, and has remained asymptomatic since. The pathologic report was acute diverticulitis with mucosal ulceration and secondary pericolic abscess. (Fig. 2.)

COMMENTS

Diverticulitis of the right colon is an uncommon lesion. It may be subdivided into

diverticulitis of the cecum and diverticulitis of the ascending colon. The latter is only one-tenth as frequent as cecal diverticulitis. Both present signs and symptoms similar to those of acute appendicitis. With knowledge of the entity of right-sided diverticulitis and attention to pertinent facts in the history, a correct preoperative diagnosis may occasionally be made. When one encounters signs and symptoms of acute appendicitis which have been rather slow in developing, and there is absence of nausea and vomiting, one should consider acute right-sided diverticulitis. Nevertheless, indications for exploration remain. It should be emphasized that on such occasions, when a normal appendix is found and Meckel's diverticulitis has been excluded, one should keep in mind the possibility of diverticulitis of the right colon.

SUMMARY

1. Four new cases of acute diverticulitis of the ascending colon are added to the literature.

2. The signs and symptoms of this disease are similar to those of acute appendicitis.

3. Optimum treatment consists of inversion or simple resection; however, because of the difficulty in differentiation from a neoplastic lesion of the right colon, a right colectomy is frequently necessary.

4. The importance of searching for diverticulitis of the right colon in the presence of a normal appendix when preoperative diagnosis has been acute appendicitis is again emphasized.

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Chemodectoma

REPORT OF CASE ARISING NEAR JUGULAR BULB AND PRESENTING IN PHARYNGEAL AND PAROTID REGIONS

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TUMORS of the glomus jugulare may develop from glomera in the adventitia of the jugular bulb, along the auricular branch of the vagus nerve and the tympanic branch of the glossopharyngeal nerve [1]. In 1955, Birrell [2] described chemoreceptor tissue within the jugular ganglion of the vagus nerve and included it as a part of the glomus jugulare complex. It is this scattered distribution of the chemoreceptor tissue that accounts for the glomus jugulare complex and most likely for the variability in the initial clinical picture. Depending on their exact site of origin, tumors of the glomus jugulare may present as vascular polypoid neoplasms in the middle ear, or they may grow posteriorly into the sigmoid sinus or medially into the cochlea; inferiorly, they may extend into the pharynx. Intracranial extension is possible when the floor of the middle cranial fossa becomes eroded.

The microscopic appearance of these tumors and of the very similar lesions of the carotid body and the vagal body is well presented in various articles [3–6], and it will not be detailed here.

It is often difficult to determine the exact site of origin of a tumor, and the larger the tumor the more difficult this becomes. Siekert [7], in 1956, recorded data in a series of thirty-three cases of tumors of the glomus jugulare seen at the Mayo Clinic; three of these tumors had extended inferiorly into the pharyngeal region. The case presented herein represents another such tumor extending into the pharynx and neck that is of added interest because of its clinical appearance and unusual size. Siekert studied the neurologic manifestations thoroughly, noting that the third through the twelfth cranial nerves, except for the fourth, have been involved.

CASE REPORT

A fifty-three year old man, who worked at a lunch counter, was referred to the Mayo Clinic in January, 1957, because of progressive difficulty in talking for four months and a mass in the right side of the jaw for four years. Fourteen years prior

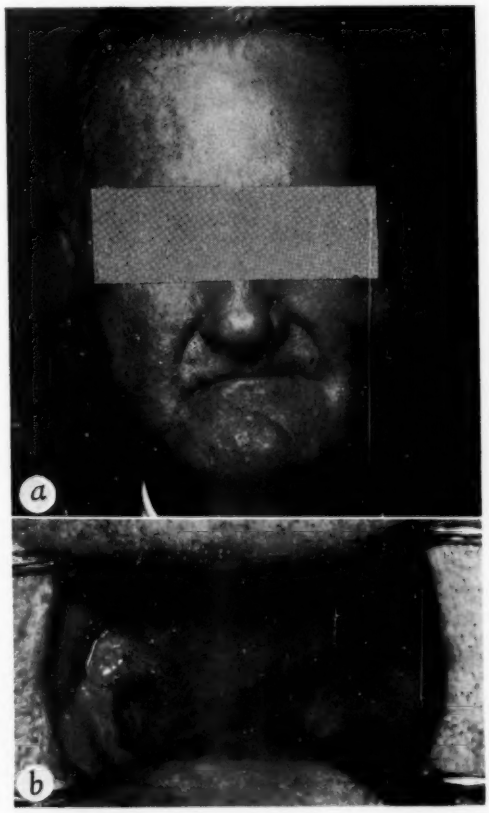

FIG. 1. Preoperative appearance. A, tumor in right parotid region. B, tumor bulging into mouth and completely filling oropharynx.

FIG. 2. Note extensive destruction of floor of middle cranial fossa, with loss of normal bony landmarks.

FIG. 3. Chemodectoma of glomus jugulare. A, cut surface of surgical specimen. B, typical nests of epithelioid cells, some with large vesicular nuclei and others with more abundant cytoplasm and hyperchromatic nuclei. Hematoxylin and eosin stain, original magnification × 80.

to admission, the patient had noted the onset of right facial weakness, difficulty in speaking distinctly, difficulty in hearing on the right, and weakness in the right arm. These changes were thought to be due to a stroke. About four years previously the weakness in the right arm had increased, phonation had become more difficult, difficulty in swallowing was noted, and a lump was first found in the region of the right parotid gland; this lump was originally thought to be the result of mumps. Four months before he came to the clinic, difficulty in talking and swallowing had increased, and the tongue was noted to deviate to the right when extruded. The lump in the right side of the jaw and face had gradually increased in size.

Examination revealed an edentulous man whose difficulty in speaking was caused, in part, by a huge mass in the right tonsillopharyngeal and right palatal regions. Externally, there was a large swelling in the right parotid region which felt soft except between the right mastoid process and angle of the jaw, where it was rubbery or "meaty." (Fig. 1A.) The mass in the tonsillopalatal area also was firm and meaty. (Fig. 1B.)

Neurologic findings included right facial weakness (seventh cranial nerve), loss of hearing on the right (eighth cranial nerve), absence of motion in muscles of the right palate which was distorted by the mass (ninth cranial nerve), weakness of the trapezius and right sternocleidomastoid muscles (eleventh cranial nerve), and atrophy, fasciculation and weakness of the right half of the tongue (twelfth cranial nerve). Weakness of the right serratus anterior and right supraspinatus muscles also was noted. The vocal cords could not be seen because of the mass.

Roentgenograms of the base of the skull disclosed destruction of much of the floor of the right temporal fossa and the pterygoid plates. (Fig. 2.)

Surgical Treatment. Preliminary tracheotomy was followed by ligation of the external carotid artery through an inframandibular incision that extended back to the right mastoid region, with a connecting incision in front of the ear. The tumor presented itself over the stylohyoid muscle and the posterior belly of the digastric muscle. At first glance, it appeared somewhat like a hemangioma because of the extremely vascular nature of the periphery of the neoplasm. The parotid gland was located, and the facial nerve, as it was stretched over the surface of the tumor and compressed against the mastoid, was identified easily, re-

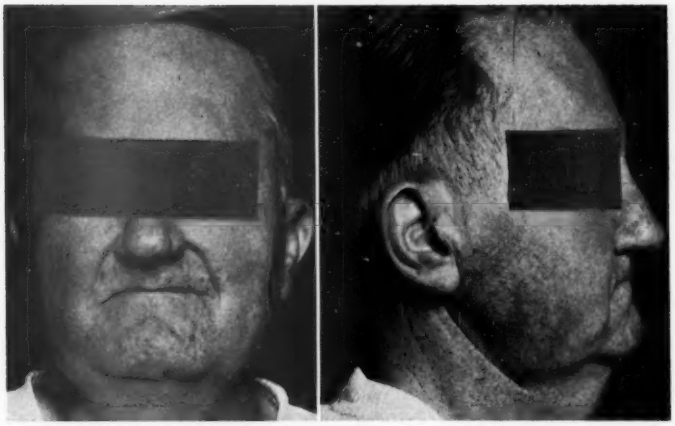

FIG. 4. Appearance six months after operation. Note surgical scar in right side of neck, with extension into preauricular region.

tracted gently upward and dissected from the tumor. For the most part, the tumor was freed from its bed by dissection with the fingers and by careful dissection with scissors, all vessels being ligated as they were encountered. At one point, the tumor was firmly attached to the base of the skull in the region of the jugular foramen. Removal was facilitated by fracturing the styloid process of the temporal bone, allowing the tumor, which measured 10 by 8.5 by 4 cm., to be removed in one piece from between the mandible and the base of the skull.

Pathologic studies disclosed that the tumor was a chemodectoma. (Fig. 3.)

Course. The nasogastric feeding tube was removed on the third postoperative day and the patient was able to take a soft diet. The tracheotomy tube was removed on the fourth postoperative day. The patient left the hospital eight days after operation, with much improvement in speech and swallowing. Examination of the larynx, which was not possible before operation because of the mass, revealed a fixed right vocal cord, indicating damage to the tenth cranial nerve. Postoperative paralysis of the right facial nerve was present, although it was anticipated that this would be only temporary since the trunk of the facial nerve was preserved at operation. The patient was allowed to go home three weeks after operation.

He returned for observation six months later, looking extremely well. No evidence of the original tumor could be noted. (Fig. 4.) Minimal weakness of the facial nerve, similar to that seen preoperatively, was present, and the right vocal cord remained in its fixed position. Examination of the middle ear did not disclose any evidence of tumor in the temporal bone; roentgen therapy was not advised until such time as symptoms might suggest some tumor in this location.

Subsequent follow-up eighteen months after operation again failed to disclose any evidence of recurrence of the tumor. The otorhinolaryngologist did not think that any treatment of the middle ear was necessary at this time. Evidence of involvement of the temporal bone or middle ear could not be demonstrated.

COMMENTS

In this case, the insidious and progressive course of the disease over a period of fourteen years, with ultimate involvement of the seventh through the twelfth cranial nerves on the right side, is characteristic of this lesion. The great size of the tumor in the tonsillopharyngeal and right palatal region, the parotid mass and the roentgenographic evidence of destruction in the middle cranial fossa are all features contributing to the unusual and complex surgical problems associated with this chemodectoma.

The tumor was large and presented a real challenge from the surgical standpoint. The lesion was so large that the patient's speech was difficult to understand; swallowing and breathing were becoming more and more difficult, which finally forced him to seek help.

The neurologic deficit, gradually developing for fourteen years, was first manifest in the seventh and eighth cranial nerves, with later involvement of the ninth through the twelfth cranial nerves.

Chemodectoma, neurofibroma and mixed tumor were considered in the differential diagnosis; however, as with all tumors of the neck, the clinical impression is at best only an educated guess, and surgical exploration is always in order. The external

approach, with ligation of the external carotid artery and exposure and control of the internal carotid and internal jugular veins, is important.

SUMMARY

A fifty-three year old man gave a fourteen-year history of gradual development of symptoms which indicated involvement of the seventh through the twelfth cranial nerves. A large mass in the right side of the jaw had been present for four years. Roentgenography disclosed evidence of destruction of the middle cranial fossa.

Surgical removal of a large chemodectoma arising near the glomus jugulare and involving the pharyngeal and parotid regions was accomplished successfully, with great improvement in the patient's appearance and symptoms.

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Chondrosarcoma in a Phalanx

REPORT OF A CASE

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IN 1929 Phemister [1] described chondrosarcoma of bone as a distinct clinical and pathological entity, and separated it from the general category of osteogenic sarcoma. The long tubular bones and the flat bones of the trunk are the common sites of involvement. Chondrosarcoma of the hand and foot is an extremely rare condition.

In reviewing ten cases of chondrosarcoma, Lichtenstein and Jaffe [3] described one patient with the lesion in a finger phalanx. In reviewing seventy-four cases, Morton and Mider [5] noted two patients with the lesion in a finger phalanx and one with the lesion in a tarsal cuneiform. In a series of fifty-two cases, Coley and Higinbotham [1] noted one instance of chondrosarcoma of a metacarpal. In an extensive series of 212 cases, Dahlin and Henderson [2] noted two patients with the lesion in a metacarpal and two patients with the lesion in a tarsal cuneiform.

CASE REPORT

A forty-three year old white woman, in whom a secondary central chondrosarcoma of a phalanx arising in an enchondroma developed, was admitted to the Hospital for Special Surgery on April 23, 1959. Four years prior to admission she had noted the gradual onset of swelling in the proximal portion of the left index finger. Gradually the finger became painful, and in August 1956 she was admitted to another hospital where the lesion was curetted and the defect packed with bone chips. Following surgery, the pain remitted and full function returned to the finger. However, the enlargement persisted. The patient felt well until two months prior to admission when the finger again became painful and enlarged.

On examination the pertinent findings were limited to the left index finger. A smooth fusiform enlargement about the proximal phalanx was noted; this measured 2.5 cm. in its greatest diameter. There was a well healed surgical incision lateral to the proximal phalanx. The area was tender to palpation. However, there was no evidence of inflammation or induration. Regional lymph nodes were not palpable.

Routine laboratory studies were within normal limits. On April 24, 1959 an excisional biopsy was performed through a medial incision. At surgery the periosteum was noted to be thickened and peeled from the cortex with difficulty. The cortex was thinned and readily cut with a scalpel. A small slot was made in the cortex and the marrow cavity curetted. Grossly, the lesional tissue appeared pearly white and had a gritty consistency. A pathological diagnosis of early chondrosarcoma was made on permanent section and on May 1, 1959 a ray resection of the left index finger was performed. Six weeks following surgery, the patient returned to full employment as a sales clerk.

The initial roentgenograms of this lesion, taken in July 1956 show an irregular radiolucent expanding lesion within the proximal end of the proximal phalanx. (Fig. 1.) There was slight irregularity of the cortex and periosteal new bone formation is seen on the volar aspect of the lesion. The periosteal new bone is smooth and without evidence of destruction. The appearance is typical of an enchondroma of the finger.

Figure 2 represents a photomicrograph of the original lesion. In this area most of the cartilaginous cells are small with single nuclei. However, there is more than an occasional cell exhibiting binucleation. Aside from this feature, the area has a benign appearance.

Recent roentgenograms taken in April 1959 demonstrate irregular enlargement of the proximal phalanx with several small areas of rarefaction. However, there is nothing to suggest malignant degeneration. (Fig. 3.)

Figure 4 is a photomicrograph of the tissue obtained from the biopsy in April 1959. When compared with Figure 2, definite cytologic change can

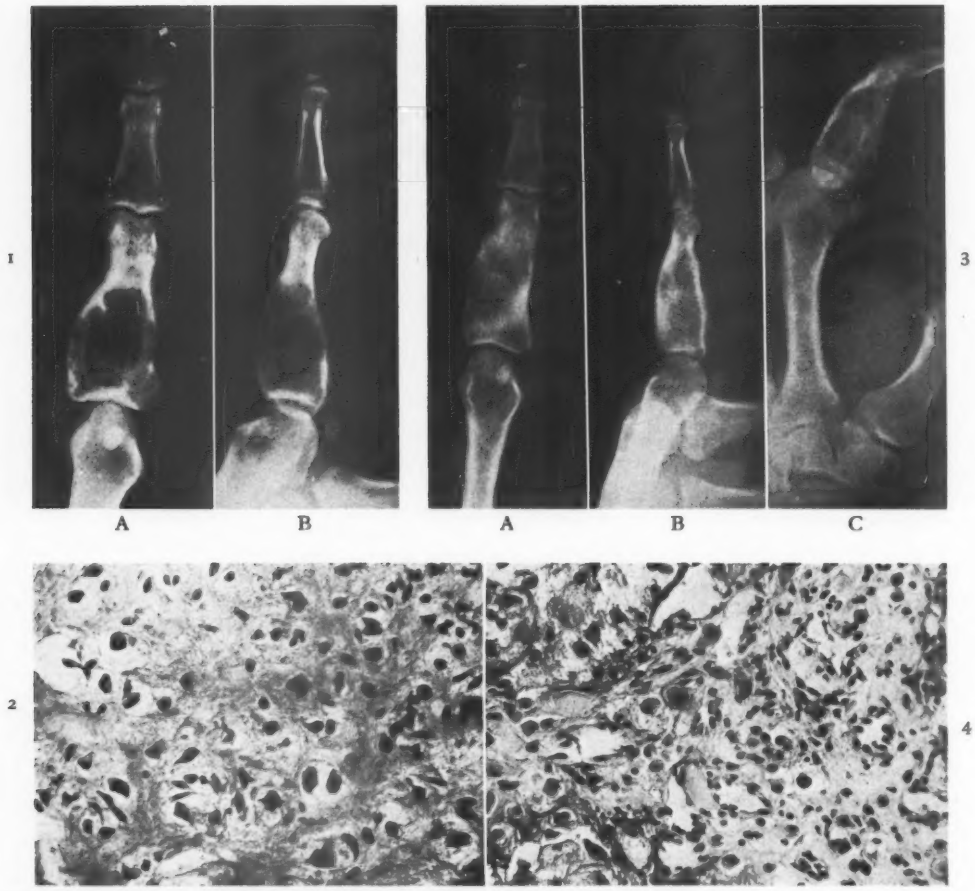

FIG. 1. Lesion in proximal phalanx of left index finger, July 25, 1956.

FIG. 2. Microscopic study of the lesion at original operation in August 1956.

FIG. 3. Three radiographic views of the recurrent lesion, August 23, 1959.

FIG. 4. Photomicrograph of biopsy specimen. Note increased cellularity, binucleation and nuclear enlargement.

be noted. There are several cells exhibiting binucleation and nuclear enlargement. Cells with rather large nuclei are also evident. A giant cell with a large hyperchromatic nucleus is seen in the center of the field. Lichtenstein and Jaffe have stressed these findings and point out that they should be seen in a viable non-calcified area.

SUMMARY

A rare lesion of chondrosarcoma arising in an enchondroma of a finger is reported. The radiological and microscopic features are discussed.

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Primary Reticulum Cell Sarcoma of the Femur

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PRIMARY reticulum cell sarcoma of the bone is a rare entity. Prior to 1936, it was most often classified as Ewing's sarcoma. Some cases were considered to be Hodgkin's disease, lymphosarcoma or osteogenic sarcoma. Ewing [1] credits Kaufman as being the first to recognize primary reticulum cell sarcoma of the bone. In 1928, Oberling described the potentialities of the reticulum cell. Ewing reclassified sarcoma of the bone by identifying primary reticulum cell sarcoma as a specific entity following the publication of a report of seventeen cases by Parker and Jackson [2] in 1939. In 1947, Sherman and Snyder [3] noted the predilection of this tumor for the vicinity of the knee. In 1950, Coley, Higinbotham and Groesbeck [4] presented the largest series of patients reported up to then. Of fifty-eight patients with reticulum cell sarcoma of bone, they found thirty-seven with either a primary focus in a single bone on admission or, if metastases were present, the history of a primary tumor for at least six months before spread. In 1958, Rosenberg, Diamond, Dargeon and Craver [5] concluded that the problem of reticulum cell sarcoma arising in bone as a distinct entity had not been resolved but agreed upon the usefulness of such a concept [6].

CASE REPORT

G. K., a thirty-seven year old white man, developed pain associated with swelling and warmth of the right knee in August, 1952. Following rest of the extremity for several days, there was a complete disappearance of symptoms. Thereafter, however, the pain and swelling recurred at three to four week intervals and lasted for one to two days. Local compresses and aspirin usually gave relief. In April, 1953, atrophy of the right thigh muscles was noted. Roentgenograms at that time were negative. (Fig. 1, *top.*) In February, 1954, following study elsewhere, the right knee was explored. Films were made on February 16, 1954, before operation. (Fig. 1, *center.*) A torn medial meniscus was found. The femoral cartilage biopsy revealed "gout." Thereafter, therapy was directed toward the treatment of gout; colchicine and steroids were prescribed. In spite of treatment the patient continued to have exacerbations of pain and swelling at three to four week intervals. In February, 1956, the pain became less acute but persisted for longer periods of time, lasting one to two weeks. In August, 1956, he was admitted to The Long Island College Hospital for further study of the problem. At that time the right knee was warm, swollen and tender with marked limitation of flexion and extension. There was moderate atrophy of the muscles of the right thigh. Physical examination was otherwise within normal limits. Neither the spleen, liver nor lymph nodes were palpable. Blood and urine studies were within normal limits. The sedimentation rate was not accelerated.

Past history revealed rheumatic carditis at the age of thirteen. There were no joint manifestations with that episode and there were no known sequelae. He had served in the Air Corps during World War II as a combat pilot.

Roentgenograms of the right knee on September 2, 1956, revealed a destructive process in the distal right femur. (Fig. 1, *bottom.*) The radiologic appearance was characterized by mottling caused by alternate areas of lucency and increased density. There appeared to be several breaks in the cortex medially and posteriorly with invasion of soft tissues posteriorly. The knee joint was aspirated, and 55 cc. of straw-colored fluid containing fibrin, polymorphonuclear neutrophils and lymphocytes (but no tumor cells or bacteria) were ob-

FIG. 1. *Top*, films made nine months after the onset of symptoms show slight increase in density of the distal femur. *Center*, approximately one and a half years after onset of symptoms a definite increase in density of the distal femur and mottled appearance on the lateral projection are seen. *Bottom*, films made prior to biopsy show rather diffuse mottling of the distal femur with definite evidence of destruction of the cortex at several sites anteriorly and posteriorly. There appears to be soft tissue invasion posteriorly.

tained. A preliminary diagnosis of primary tumor of the bone was made.

On September 13, 1956, the distal right femur was explored and a large biopsy was taken. Microscopic study showed the tumor cells to be small to medium in size and diffusely infiltrating the fibrous tissue was well as cortical bone. There was no definite pattern. The individual tumor cells showed very scanty, slightly eosinophilic cytoplasm and vesicular or pyknotic nuclei. Mitoses were present in moderate numbers. Scattered multinucleated cells were present. Necrosis was slight. The stroma was minimal. Lymphocytes were noted between the tumor cells. (Figs. 2A and B.)

X-ray therapy was started. Between October 18, 1956 and November 6, 1956, he received deep x-ray therapy using the following factors: 200 kv., 50 cm. distance and, for the first half of therapy, 1 mm. of aluminum and .5 mm. of copper filtration with a half value layer of .9 mm. copper. For the second half of therapy, a thoreus filter was used with a half value layer of 1.8 of copper. The patient was quite tall and since we wished to treat at least the distal two-thirds of the femur and the proximal tibia, it was necessary to use two anterior and two posterior ports. During the treatment period (three weeks elapsed) the patient received a total of 2,700 r in air to the upper anterior port and 2400 r in air to the upper posterior port. He received 2,700 r in air to the lower anterior port and 2,500 r in air to the lower posterior port. His thigh measured 11 cm. proximally and 10 cm. distally. The mid-plane tumor dose was 4,590 r to the upper thigh and 4,940 r to the lower thigh. The patient had a marked dry desquamation, but the skin never actually became wet. Another course of therapy was started four months later (March 21, 1957). This time lateral ports were used. An additional tumor dose of 1,400 r was given to the entire thigh. This made a total tumor dose of 6,000 r to the upper thigh and 6,400 r to the lower thigh and knee. In the immediate follow-up period, the patient had a moderate amount of edema and marked induration of the skin in the treatment area, especially around the knee. He also had swelling of the soft tissues below the knee. Gradually the skin bronzed and became quite tight causing some limitation of motion. Five months following therapy, the patient discarded his crutch and started walking with a cane; one month later he was able to walk without any support. The patient is now active and well and is working full time.

Follow-up films show some improvement in the appearance of the distal femur. There has been filling-in of some of the lucent areas and the cortex of the bone has reappeared at former sites of destruction. The roentgenograms taken one year after therapy are shown in Figure 3A and the most

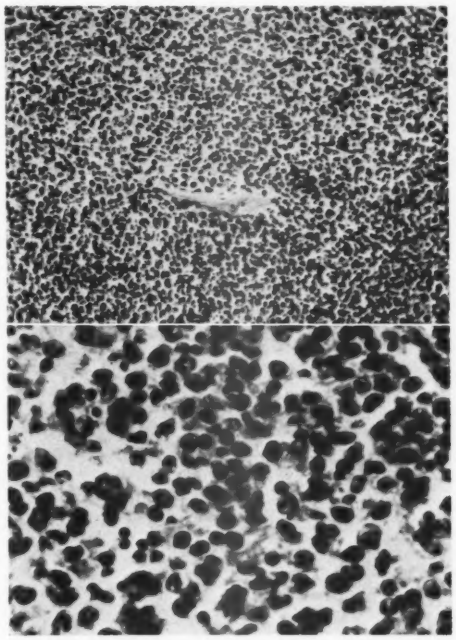

FIG. 2. A, reticulum cell sarcoma of bone showing solid sheets of tumor cells surrounding a residual spicule of bone. Original magnification × 125. B, there is moderate pleomorphism of the neoplastic cells. Original magnification × 650. Hematoxylin and eosin stain.

recent films, taken twenty-one months after the start of treatment, are shown in Figure 3B. Figure 3C, a roentgenogram taken on July 1, 1960, shows further filling in of the lucent areas in the distal femur.

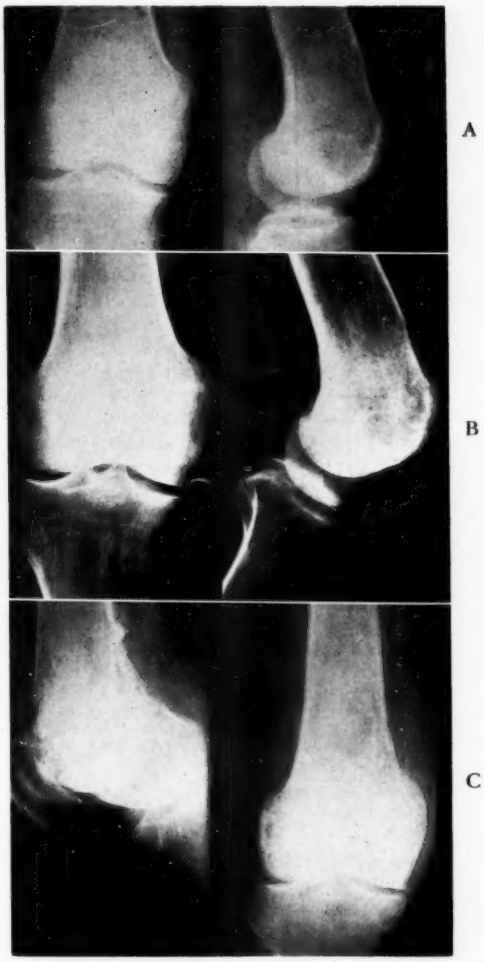

FIG. 3. A, the large lucency is the site of the biopsy. B, note partial filling of areas of destruction. No soft tissue mass is detected posteriorly. C, continued improvement in the appearance of the distal femur.

COMMENTS

Primary reticulum cell sarcoma of bone is a malignant tumor which is usually seen in the long bones. It is evenly distributed among the adult groups up to the age of forty. It occurs more frequently in men. In the generalized form of the disease, the metastatic lesions occur more commonly in the vertebral bodies and the skull. The early clinical course is characterized by pain with or without swelling and relief by rest. Pathologic fractures rarely occur. Occasionally, painless swelling is the earliest manifestation. The patients are usually in good general health, although some have weight loss and loss of strength. Laboratory tests are normal. Fever is uncommon. There is no evidence that trauma has an etiologic significance.

Radiographically, the appearance depends upon the stage of the disease. Early in the disease, one may see very little except a slight increase in density in the area of involvement. Such was the finding in this case. Later there is a combination of areas of osteolysis as well as sclerosis. The cortex eventually becomes involved and destroyed; when this happens, there is frequently invasion of the soft tissues. Periosteal reaction is not a prominent feature, although it does occur. There may be widening of the medullary portion of the bone.

From a gross pathologic standpoint, the

tumor is pale white, gray-white or pinkish gray, with or without areas of necrosis. However, the diagnosis of reticulum cell sarcoma cannot be made without a microscopic examination. Histologically, the cell and its nucleus is larger than the lymphocyte. The nuclei are indented or lobulated, eosinophilic or basophilic. It is possible that these tumor cells arise from primitive reticulum cells which are responsible for the development of lymphocytes and not from cells responsible for other hematopoetic elements.

SUMMARY

A case of primary reticulum cell sarcoma of bone is presented. In spite of the delay in instituting therapy, the lesion shows no evidence of spread. The patient was treated with x-ray therapy; the total tumor dose was approximately 6,000 r. This case provides additional evidence for the concept of exclusive involvement of a solitary organ in what is generally considered to be a widely disseminated disease.

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Hyperparathyroidism Associated with Intrathyroid Parathyroid Glands

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During the course of surgery for hyperparathyroidism the surgeon is frequently confronted with the problem of identifying parathyroid tissue in a variety of anatomic locations. It is well known that adenomatous or hyperplastic glands may be present in various areas of the neck as well as superior mediastinum. For the most part, these ectopic sites may find explanation in the embryologic derivation of the parathyroid glands from the third or fourth branchial clefts.

Although several reports of parathyroid tissue within the substance of the thyroid gland are present in the literature [5,6], Cope [4] doubted the presence of parathyroid glands in such a location. The purpose of this communication is to report two cases which illustrate the intrinsic relationship of parathyroid with thyroid tissue. In the first case a parathyroid adenoma appeared to be such an integral part of the thyroid gland that it was removed with the belief that it was a thyroid adenoma. The second case, to our knowledge, is the eleventh case of primary chief cell hyperplasia to be reported. This case shows the difficulties associated with subtotal removal of hyperplastic glands as well as the confusion resulting from cervical extension of the thymus gland.

CASE REPORTS

Case I. C. P., a forty-one year-old white man, presented with a one-year history of renal lithiasis, sciatic pain and peptic ulcer-like symptoms. The clinical impression was probable primary hyperparathyroidism. Laboratory examination demonstrated a serum calcium of 16.6 mg. per cent. (Fig. 1.) Urinary calcium excretion was 683 mg. in twenty-four hours. Serum phosphorus was 2.2 mg. per cent.

Surgical exploration of the neck on July 17, 1959, revealed parathyroid glands adjacent to each inferior thyroid artery. The left gland was larger and appeared adenomatous. Vascular pedicles were seen passing from the inferior thyroid artery directly to these glands. A thorough search for superior parathyroid tissue was unrewarding. An obvious enlargement of the inferior pole of the left lobe of the thyroid was noted. (Fig. 2.) Because of this apparent solitary thyroid adenoma a left thyroid lobectomy was performed including the structure identified as a left parathyroid. Postoperatively the patient did well. Serum calcium fell to normal (Fig. 1) and serum phosphorus began to rise. Microscopic examination of the surgical specimen showed the structure identified as left parathyroid to be, instead, a thyroid adenoma. The enlargement of the inferior pole of the left lobe of the thyroid which appeared to be a thyroid adenoma at surgery was a large parathyroid adenoma embedded in the thyroid gland. Microscopically, it was composed of dense sheets of eosinophilic-staining cells of the chief type. (Figs. 3A and B.)

Comment: This case is of interest in that the parathyroid adenoma presented on the caudalmost aspect of the left hemithyroid gland and when observed at surgery appeared to be a thyroid nodule. On microsection it was obvious that this nodule represented a parathyroid adenoma (Figs. 3A and B) which was adherent to the thyroid and partly surrounded by thyroid tissue.

Case II. F. R., a thirty-eight year-old man, was admitted with symptoms suggestive of duodenal ulcer and herniated intervertebral disc. The symptoms were of four months' duration. Laboratory examination showed a serum calcium of 15.5 mg. per cent and serum phosphorus of 3.1 mg. per cent. The twenty-four–hour urinary calcium excretion was 462 mg. and the twenty-four–hour urinary phosphorus was 869 mg. Ab-

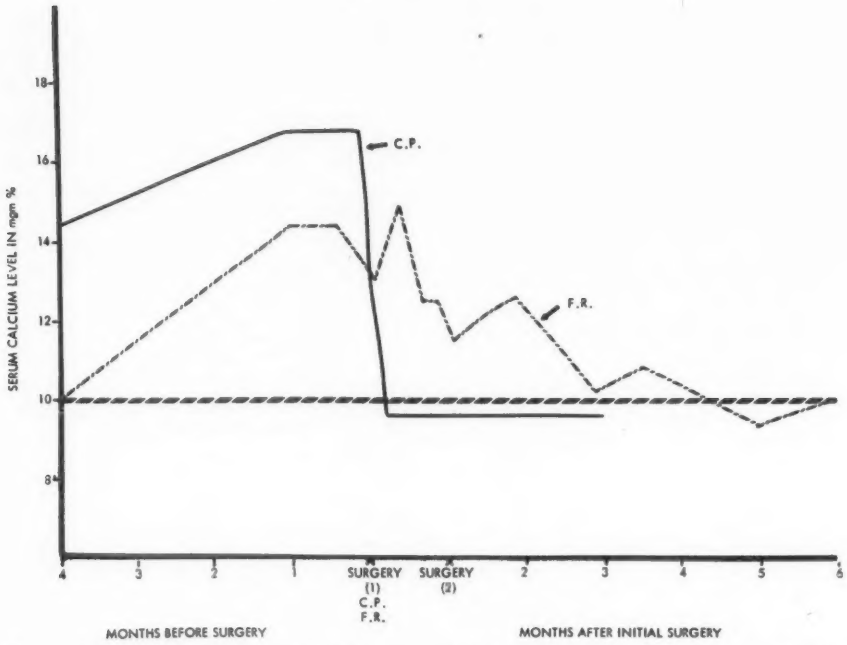


FIG. 1. Prompt decrease to normal of the serum calcium level in the patient with a parathyroid adenoma. Prolonged elevation of the serum calcium following surgery in the patient with primary hyperplasia of the parathyroid glands.

dominal roentgenogram suggested nephrocalcinosis. Renal biopsy showed renal calcinosis associated with secondary pyelonephritis. The diagnosis of primary hyperparathyroidism was made and surgical exploration of the neck was accomplished on May 21, 1958.

At operation, four enlarged parathyroid glands were thought to have been identified. The left superior and inferior parathyroid and one-half of the right superior parathyroid, each measuring 1 by 0.5 cm., were removed. Microscopic examination of the parathyroid glands showed irregular cords of chief cells with small to round nuclei with a granular, slightly eosinophilic-staining cytoplasm. The cell type was uniform. No cells of the water-clear type were seen. (Fig. 4.) What was thought to be right inferior parathyroid gland at surgery was shown microscopically to be thymus gland and, therefore, only two and one-half parathyroid glands had been removed. Following surgery the patient showed some relief from the ulcer and intervertebral disc symptoms. However, laboratory data (Fig. 1) showed the hyperparathyroid state to be only partially relieved. Exploration of the neck and anterior mediastinum was performed on June 27, 1958, using a cervical and sternal splitting incision. The thymus gland, a portion of which extended into the right part of the neck, and the right lobe of the thyroid gland were removed. The right inferior parathyroid gland was identified in the surgical specimen. Thus, a total of three and one-half grossly enlarged parathyroid glands were removed. Serum calcium did not show a significant decline until two months after the second surgical procedure. Today the patient is doing well and is asymptomatic with serum calcium and phosphorus and urinary calcium

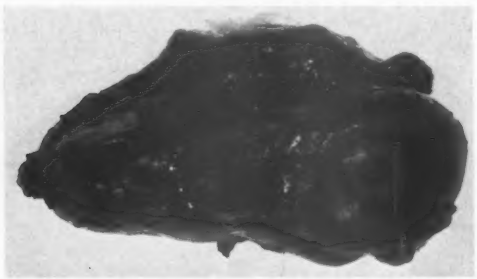
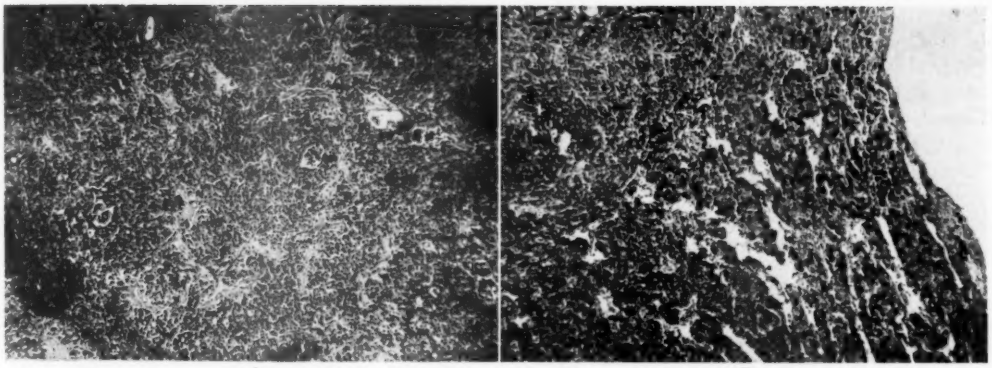


FIG. 2. Gross surgical specimen of the patient with a parathyroid adenoma. The 1.5 cm. mass at the inferior pole of the thyroid is a parathyroid adenoma nearly embedded in the thyroid tissue.



3A 3B

FIG. 3. Microsection of parathyroid adenoma. A, showing chief cells. B, showing extreme pleomorphism which may exist in a benign tumor.

and phosphorus within normal limits. The alkaline phosphatase is no longer elevated.

Comment: In this case the failure to locate an obvious parathyroid adenoma at any of the usual sites led us to suspect the existence of diffuse hyperplasia of the four glands or the alternate possibility of a mediastinal location. Because of the apparent enlargement of all four glands associated with a coffee brown color, it was elected to remove both superior and inferior glands on the left as well as half of each gland on the right.

Microscopic identification of the right inferior gland as thymic tissue led to the belief that perhaps the right inferior gland was adenomatous or hyperplastic and was located in the superior mediastinum. The failure of the serum calcium to fall to normal limits during the postoperative period confirmed our fears that the patient still harbored hyperfunctioning parathyroid tissue. Accordingly, when the superior mediastinotomy showed cervical extension of the thymus to the right inferior pole of the thyroid, it was clear why thymic tissue had been obtained rather than the right inferior parathyroid gland. In an effort to locate the fourth and remaining gland the lower pole of the thyroid gland was resected. Later examination demonstrated this tissue to contain the hyperplastic parathyroid in a subcapsular location partly surrounded by thyroid tissue.

COMMENTS

Two patients with hyperparathyroidism, each presenting a comparatively rare surgical finding, were treated at the Seattle Veterans Administration Hospital during 1958 and 1959.

Examination of the parathyroid glands in dogs and other experimental animals shows wide variation in location and size of the parathyroid glands. The superior parathyroid glands originating from the branchial clefts become attached to and may be embedded within the thyroid gland, although this rarely happens in man [7]. Cope [4] stated that although parathyroid tissue from the fourth branchial cleft could be embedded in the thyroid, he had never observed such a finding. He has found parathyroid tissue deep within the sulcus of the thyroid.

If the surgeon makes the diagnosis of primary hyperplasia of the parathyroid glands after identifying all of these structures, then he must

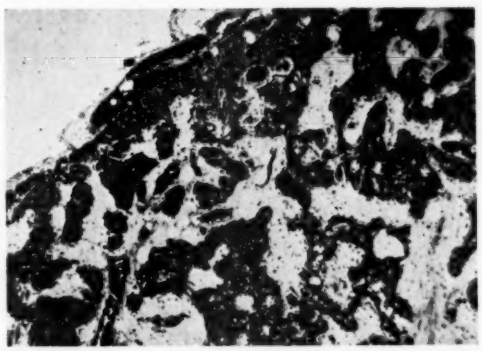


FIG. 4. Microsection of surgical specimen from the patient with primary chief cell hyperplasia of the parathyroid glands.

determine the amount and probable vascularity of remaining tissue if hypoparathyroidism is to be prevented. Both Cope [4] and Black [1] recommended subtotal resection of parathyroid tissue; the latter author suggests leaving a vascularized segment of tissue two or three times the size of normal parathyroid tissue.

Primary hyperplasia of the parathyroid glands is found in approximately 10 per cent of patients with primary hyperparathyroidism [1]. The usual cases are characterized by hyperplasia of the water-clear or "wasserhelle" cells rather than the chief cells. Cope [3] has recently described a new entity of chief cell hyperplasia occurring in ten patients. Case 11 appears to represent the eleventh case of this type.

In addition, Case 11 shows the failure of cure of this disease when only two and one-half hyperplastic glands were removed and, in turn, the successful treatment of primary hyperplasia of the parathyroids when three and one-half glands were removed. In this case all parathyroid tissue removed appeared similar microscopically (Fig. 4) and was consistent with a diagnosis of chief cell hyperplasia of the parathyroids.

In these two cases the success of surgery can be attributed to hemithyroidectomy, as the abnormal parathyroid tissue was found in the surgical specimen after it had been removed. It would be our opinion that any abnormality detectable in the thyroid gland at the time of exploration of the neck for hyperparathyroidism should be treated with hemithyroidectomy.

Case 11 demonstrates a very slow fall in the serum calcium levels following surgery. (Fig. 1B.) This was disturbing to the physicians following the case and is presented only as an unusual variation of the clinical response of this disease to surgery for which we have no explanation at present.

The presence of thymic tissue in the neck in Case 11 is presented as an additional finding which may cause confusion while trying to identify the parathyroids at surgery. Considering its embryonic origin, it is not surprising to find part of the thymus in the neck associated with the inferior parathyroid gland, which also arises from the third branchial cleft. Realization that thymic tissue may be in the neck and careful study of such tissue by frozen section may serve to differentiate this from parathyroid tissue.

SUMMARY

A single case of primary chief cell hyperplasia of the parathyroid glands is presented and the technical problem of differentiating parathyroid gland from thymus gland is described.

A single case of a parathyroid adenoma found within the thyroid gland is presented and the relationship of the parathyroid glands to the thyroid gland is discussed.

Acknowledgment: We wish to thank Dr. Benjamin Castleman, Professor of Pathology, Harvard University, Cambridge, Massachusetts, for kindly reviewing the slides in Case 11.

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Cutaneous and Intestinal Neurofibromatosis

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TUMORS of the small intestine are rare. One of the least common of the benign tumors is that of neurogenic origin. The case reported herein demonstrates the difficulty in correct preoperative diagnosis with attendant delay of over two years between the first episode of melena and surgical treatment.

CASE REPORT

A thirty-six year old white male tool grinder was admitted for the third time to the Newington Veterans Administration Hospital in October 1959, with a chief complaint of melena and increasing weakness for two weeks prior to admission.

Past history and systemic review were negative except that relating to the present illness.

In about 1940 the patient first noted the development of generalized subcutaneous swellings which gradually increased in size and number. Except for irritation of several of the lesions located at friction points, there were no symptoms. No similar lesions had been noted in his mother, father, or seven siblings.

In 1948 a skin biopsy by a dermatologist is said to have shown a neurofibroma.

In 1949 the patient was first admitted to Newington for diagnosis of the skin condition. Biopsies of two of the lesions were reported as cutaneous fibromas.

In 1957 the patient was admitted to another hospital because of an episode of melena lasting one week. He was treated with 500 cc. of blood and discharged with a diagnosis of duodenal ulcer. Gastrointestinal series and barium enema at that time were negative for abnormalities.

In August 1959, the patient was again admitted to Newington because of two weeks of intermittent melena, increasing weakness and easy fatigability. He denied abdominal pain, nausea or vomiting, hematemesis, indigestion, dyspepsia, or heart burn. Regular bowel movements occurred twice daily.

Physical examination revealed no abnormalities except for the presence of multiple, soft, freely movable subcutaneous nodules varying in size from several millimeters to 2 to 3 cm. (Fig. 1.) There were small café-au-lait spots on the flexor surface of the right forearm and the left anterior cervical region. Stool on the examining glove was positive for blood.

Routine laboratory work-up was within normal limits except for a hematocrit of 20 per cent on admission. The patient was placed on a regimen of iron and an ulcer diet and received 1,000 cc. of whole blood. Stool guaiacs remained positive for five days and then became consistently negative. On the fourth day of this admission a string test

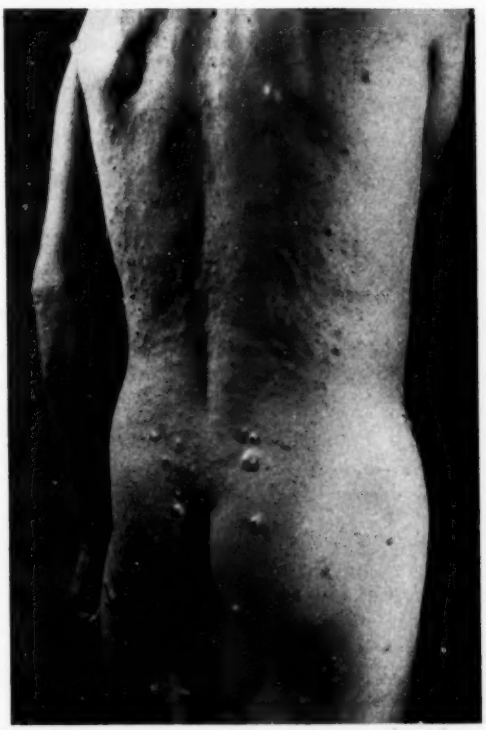

FIG. 1. Gross appearance of neurofibromas covering the patient's body.

FIG. 2. Appearance at time of operation of the two largest neurofibromas. Note the prominent blood supply of the intramural tumor at the left.

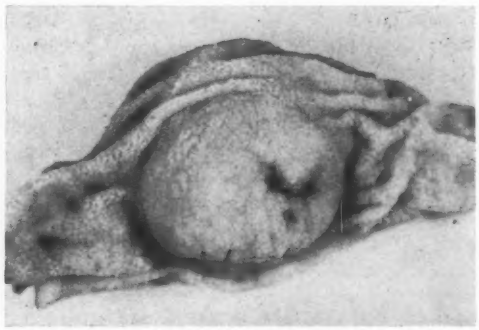

FIG. 3. Opened specimen of resected ileum. Ulceration on the mucosal aspect of the intramural neurofibroma can be seen.

revealed no evidence of blood as far as the ampulla of Vater. Gastrointestinal series showed a normal esophagus and stomach. A 2 mm. filling defect was noted in the duodenum 3 cm. beyond the pyloris suggesting a duodenal ulcer. Study of the jejunum and ileum by twenty minute, forty minute, one, two, three and five and a half hour films demonstrated no abnormalities. Barium enema and air contrast study were within normal limits. Gastroscopy revealed antral gastritis. Sigmoidoscopy to 25 cm. was negative.

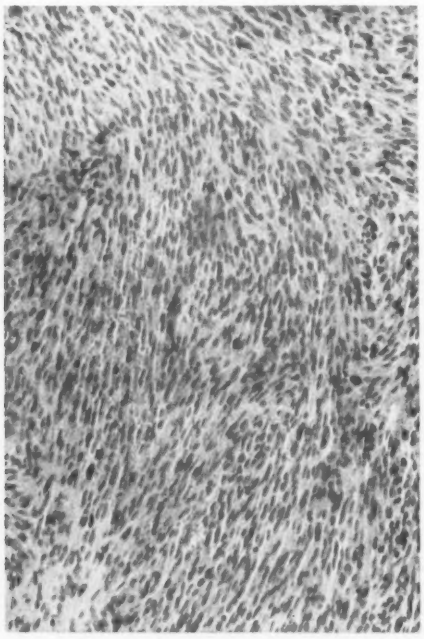

FIG. 4. Microscopic appearance (hematoxylin and eosin stain) of one of the neurofibromas.

An additional biopsy of a skin lesion was interpreted as a neurofibroma.

The patient was discharged after nineteen days on an ulcer diet with a diagnosis of duodenal ulcer.

The patient was admitted in October 1959, to Newington for the third time. He was again free of gastrointestinal symptoms but had noted a tarry stool two weeks prior to admission. Because of increasing weakness, fatigue and exertional dyspnea, he saw his family physician who found anemia and referred him to the hospital for evaluation.

Physical examination was unchanged from that two months previously except that stool on the examining glove was guaiac-negative. Hematocrit on admission was 24 per cent. A string test with the metallic slot in the duodenum by roentgenograms was positive for blood 50 cm. from the mouth the day following admission. A gastrointestinal series again showed a tiny niche 2 mm. in size 3 cm. beyond the pyloris suggesting a duodenal ulcer. Over the first nine days of this admission stool guaiacs were negative, and hematocrit rose to 39 per cent on iron and an ulcer regimen. Subsequently, hematocrit dropped to 35 and then 33 per cent and stool examinations became positive for blood and remained so until transfer of the patient to the surgical service two weeks after admission.

On October 29, 1959, the patient underwent exploration. Examination of the stomach and duodenum was negative for ulcer. Eight nodules were found arising from the antemesenteric wall of the small intestine from the duodenum to the distal ileum. A nodule in the third portion of the duodenum and nodules in the jejunum and proximal ileum were serosal in origin and measured 2 to 3 mm. in size. A larger tumor in the proximal ileum was 1.5 cm. in diameter and was pedunculated. In the mid-ileum another tumor 2.5 cm. in size occupied an intramural position. Its external aspect showed an inflammatory reaction and mesenteric

vessels supplying this segment of ileum were markedly enlarged. Blood was seen in the bowel distal to this tumor. No nodules were seen in the mesentery of the small bowel or in the wall of the colon. The two largest tumors are shown in Figure 2.

Duodenotomy was performed without finding evidence of ulceration, and the duodenum was closed. The six smaller tumor nodules were removed without entering the bowel lumen. The pedunculated tumor was removed across its base, closing the bowel in two layers transversely. The intramural tumor was resected along with a segment of proximal and distal ileum and wedge of mesentery because of the possibility of sarcomatous degeneration. An end-to-end anastomosis was performed, and the abdominal incision closed after appendectomy.

Gross examination revealed two superficial erosions on the mucosal aspect of the intramural tumor (Fig. 3) accounting for the origin of bleeding. Microscopic diagnosis was neurofibroma in all the nodules. Figure 4 is an example of one of the sections.

The patient made an uneventful recovery and was discharged on the sixteenth postoperative day. Since that time the patient has been followed up in the outpatient department and stated on his last visit that no further bleeding had occurred.

COMMENTS

This report seems notable for a number of reasons. Neurofibromas of the small bowel are one of the more infrequent types of tumor found. The association of neurofibromas of the skin and intestinal wall is even less frequent. River et al. [*1*] in an extensive review found 1,399 cases of benign small bowel neoplasm. Only ninety were of neurogenic origin. Fourteen of these patients had cutaneous as well as intestinal lesions. Since 1956, two additional cases have been reported [*2,3*].

A second point of interest is the difficulty in correct preoperative diagnosis. The statistical preponderance of sources of bleeding from the stomach, duodenum and colon tends to make one forget the small intestine. Even when a small bowel series is performed, the majority of lesions may not be seen [*4*] although series of operative cases [*3,5*] with a predominance of malignant lesions gives a somewhat higher percentage of correct preoperative diagnosis. In the case reported herein, the large intramural tumor in the ileum was not seen even though barium traversing the small bowel was followed by roentgenogram for five and a half hours. If uniform filling of the small bowel had been obtained by passage of a tube through the pyloris [*6*], the diagnosis might have been made.

Another point of diagnostic significance is the type of bleeding which occurred in this patient. Although cases of massive hemorrhage are reported [*2*], usually bleeding is chronic leading to symptoms of fatigue, weakness and exertional dyspnea. Many times melena is not noted by the patient. Occasionally a patient will present with perforation [*7*] or obstruction [*8*] due to an intestinal neurofibroma.

SUMMARY

A case of multiple cutaneous and intestinal neurofibromas is reported. The patient bled noticeably on four occasions over a two year period before exploration led to the correct diagnosis.

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SURGICAL REVIEW

Peptic Ulceration with Associated Endocrine Tumors

COLLECTIVE REVIEW AND REPORT OF A CASE

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THE relationship of peptic ulceration to tumor or hyperplasia of one or more endocrine glands has aroused increasing interest since the report by Zollinger and Ellison [*76*] of two patients with non-insulin producing islet cell tumors of the pancreas in whom unusual peptic ulceration was present. The purpose of this paper is to report an additional similar ulcer in a patient with concurrent tumors of the pancreas, parathyroids and adrenals, and by analysis of a collective review of all reported cases to suggest that the Zollinger-Ellison syndrome as originally described only partially reflects the clinical features of this disease. The possible etiologic role of the pituitary, parathyroids and adrenals will be mentioned in addition to that of the pancreas. Cases in which ulcer recurred after surgical removal of islet cell tumors in patients whose pancreas was subsequently proved to be free of residual tumor will be cited to suggest that pancreatic tumors of the islet cell type are not in fact ulcerogenic.

HISTORICAL DATA

Wilder, Allan, Power and Robertson [*74*] in 1927 reported the case of a forty year old physician with severe hypoglycemia who died following laparotomy for an islet cell carcinoma of the pancreas. He had previously undergone gastroenterostomy for ulcer and was known to have renal calculi. The possible interrelationship of these findings was at that time not appreciated so that a description of the parathyroids, pituitary and adrenals was not included in the autopsy report. Comroe [*11*] in 1933 and Graves and Hodes [*30*] in 1941 described six cases of peptic ulcer with concomitant polyglandular abnormalities but stressed the importance of the pituitary tumor as the causative agent. Previously Lloyd [*40*] in 1929 reported the first case of multiglandular adenomas involving the pituitary, parathyroids and pancreas (islet cell); however, in this instance ulceration was not present. The association of acromegaly and parathyroid hyperplasia had been described earlier by Erdheim [*20*] in 1902 and Claude and Baudoin [*10*] in 1911. Gerstel [*27*] in 1938 reported an autopsy of a patient who had died of peritonitis following perforation of a duodenal ulcer. Acromegaly, an acidophilic adenoma of the pituitary, parathyroid adenoma, nodular adenomatosis of the adrenals and an adenoma of the pancreas were present. A patient with renal calculi, hyperparathyroidism, pituitary tumor, multiple pancreatic adenomas, hypoglycemia and duodenal ulcer with repeated hemorrhages was described by Shelburne and McLaughlin [*60a*] in 1945. The following year Sailer and Zinninger [*57*] found a malignant islet cell tumor in a patient with duodenal ulceration. Wilson, Olson and Rivers [*75*] added two cases of duodenal ulcer in patients with

TABLE 1

TOTAL CASES OF PEPTIC ULCERATION WITH ENDOCRINE TUMOR

Author	Sex and Age (yr.)	Ulcer	Parathyroid	Pancreas	Hypoglycemia	Pituitary	Adrenal	Other
Wilder et al. [74] (1927)	M,40	+	Stones	+	+			
Lloyd [40a] (1929)		○	+	+		+		
Comroe [11] (1933)	F,19	+				+		
	M,57	+				+		
Herzenberg [34] (1933)		+	+					
Gerstel [27] (1938)		+	+	+		+	+	
Friedman [24] (1939)	M,50	Gastritis		+	+	+	+	Renal adenoma
	M,56	+		+	+	+		
Graves et al. [30] (1941)	F,36	+				+		
	F,42	+				+		
	F,26	+				+		
	F,41	+				+		Acromegaly
Shelburne et al. [60a] (1945)	M,26	+	+	+	+	+		
Sailer et al. [57] (1946)	F,40	+		+	○			
Rogers [53] (1946)	M,36	+	+	○				
	M,53	+	+	○				
Wilson et al. [75] (1946)	M,27	+				+		Acromegaly
	M,45	+				+		Acromegaly
Rogers et al. [54] (1947)	M,68	+	+	Calcification				
Gordon et al. [29] (1947)	M,26	+		+			+	Perforated esophagus
Amendola [3] (1949)	F,65	+		+	○			
Machella et al. [41] (1949)	M,42	+		○				Sprue, hypoproteinemia
Waife [72] (1949)	F,34	+	+					Arteriosclerosis
	M,34	+	+					Sarcoidosis
	M,44	+	+					
Balfour et al. [4] (1950)	M,24	Menetrier's						Hypoproteinemia
Robinson et al. [52] (1951)	M,45	+	+					
Janowitz et al. [36a] (1951)	F,35	+		+	+			
Albright et al. [2] (1952)	M,48	+	+					
Forty et al. [22] (1952)	F,55	+		+				
Strøm [63] (1952)	F,32	+		+				
Cunningham et al. [13] (1952)	M,42	+	Stones	+	+		+	
Furbetta et al. [26] (1952)		+		+	+	+		
Schmith et al. [59] (1952)	M,27	+	+					
	M,42	+	+					
Underdahl et al. [68] (1953)	F,50	+	+	+	+	+		
	M,36	+	+	+	+			
Echeles [15] (1953)	F,46	+	+					
Moldawer et al. [46a] (1954)	M,46	+	+		○	+		Familial
Wermer [73] (1954)	M,41	+	○	+				Familial
	F,39	+	+	+	+	+		Familial
	F,35	○	+	+	+	+		Familial
	F,34	+	+	+	+	+		Familial
	F,32	+	○	○	○	+		Familial
Hellstrom [32] (1954)	M,22	+	+					
	M,31	+	+					
	M,48	+	+					
	M,29	+	+					
	M,48	+	+					
	F,47	+	+					
Carpenter et al. [9] (1954)	F,47	+	+					
Baumgartner et al. [5] (1954)	M,25	+	+					
		+		+	+		+	
Tsumori et al. [67] (1955)	M,10	+	+					
Zollinger et al. [76] (1955)	F,36	+		+				
	F,19	+		+				
Eiseman et al. [16] (1956)	M,39	+	+	+	+	+		
Ellison [17] (1956)	M,61	+		+				
	M,76	+		+				
	M,55	+		+				
	F,57	+		+		+		
	M,78	+		+				
McCormack et al. [45a] (1956)	M,41	○	+	+	+			
	M,48	+	+	+	+			
	F,67	+	+	+		○	+	
	M,41	+	+	+		+	+	
St. Goar [61] (1956)	M,56	+	+					
	M,46	+	+					
	M,69	+	+					
	F,50	+	+					

TABLE 1 (*Continued*)

TOTAL CASES OF PEPTIC ULCERATION WITH ENDOCRINE TUMOR

Author	Sex and Age (yr.)	Ulcer	Parathyroid	Pancreas	Hypoglycemia	Pituitary	Adrenal	Other
Busteed et al. [8] (1957)	M,37	+		+				
Donaldson et al. [14] (1957)	M,35	+	Stones	+		+	+	
Fisher et al. [21] (1957)	M,37	+	Stones	+	+	+	+	
Tedroe et al. [65] (1957)	M,34	+		+				
Recant et al. [50] (1957)	M,60	+	+	Pancreatitis				
Massachusetts General Hospital [43] (1957)	F,46	+		+				
Busteed et al. [8] (1957)	M,37	+		+				
Agna et al. [1] (1958)	F,37	+	+					
	F,32	+	+					
Cope et al. [12] (1958)	M,45	+	+			+		
	M,37	+	+					
	F,43	+	+	+	○			
	M,58	+	Stones					
			+	+		+		
		+	+	+		+		
Priest et al. [40] (1957)	F,56	+		+	○			Hypokalemia
Zubrod et al. [78] (1958)	M,45	+	+	+		+	+	Acromegaly
Headley et al. [31] (1958)	F,67	+	+					Diarrhea
MacKenzie et al. [42] (1958)	M,29	+		+				Diarrhea
	F,54	+		+				Diarrhea
Maynard et al. [44] (1958)	M,53	+		+				Diarrhea
Thistlethwaite et al. [66] (1958)	M,55	+		+				Diarrhea
	M,44	+		+				
Verner et al. [69] (1958)	M,67	○		+		+		Diarrhea
	M,19		+	+				Diarrhea
	F,57	+		+				
Zollinger et al. [77] (1958)	F,19	+		+				
	F,44	+		+				
	M,50	+		○				
Freidell et al. [23] (1959)	M,37	+		+				Diarrhea
Hendrick et al. [33] (1959)	M,28	+		+				
	F,26	+		+				
Pender et al. [47] (1959)	M,39	+		+				Familial, diarrhea
Summerskill [64] (1959)	M,35	+		Hyperplasia				Steatorrhea
Waddell et al. [71] (1959)	M,54	+		+				Diarrhea
	F,40	+		○		+	+	Diarrhea
Present case (1959)	M,38	+	+	+			+	Gonad atrophy

pituitary tumor and acromegaly. Hyperparathyroidism with peptic ulceration was described by Rogers et al. [53–55] in 1946, by Robinson, Black, Sprague and Tillesch [52] in 1951, and by Albright and Kerr [2] in 1952. Atypical peptic ulceration with islet cell adenomas of the pancreas was reported by Gordon and Olivetti [29] in 1946, and by Forty and Barrett [22], Strøm [63] and Cunningham, Howe and Evans [13] in 1952. Furbetta and Santucci [26] in the same year described an acromegalic patient with hypoglycemia and ulcer. In 1953 Underdahl, Woolner and Black [68] reported eight cases of multiple adenomas involving the parathyroids, pituitary and pancreatic islets. Ulcer was present in two of these. The familial tendency of multiple endocrine adenomas was described by Moldawer, Nardi and Raker [46a] in 1954, and in the same year Wermer [73] reported on a family in which the father and five children demonstrated abnormalities of the pituitary, parathyroids, pancreas and gonads with concurrent ulcer in five of the six. Frohner [25a] previously had described five cases of hyperparathyroidism occurring in a family but in these patients ulceration was not present [25b]. Zollinger and Ellison [76] published their cases in 1955; the syndrome was not named as such until it was so designated by Eiseman and Maynard [16] the following year.

PRESENTATION OF DATA

In Table 1, all of the cases compiled in this study are listed in chronological order. A total of 107 cases are included of which 101 patients demonstrated both ulceration and one or more endocrine tumors or hyperplasia. Six cases without ulcer are shown because of significant similarities to the general syndrome. The ratio of men to women was slightly less than 2:1 as compared with the usual ratio of 3:1

[18,37,46A]. Age ranged from ten to seventy-eight years with 56 per cent of the patients between the ages of thirty and forty-nine years. A general summary of Table I is appended in Table II.

Peptic ulcer occurred in association with multiple endocrine tumors involving more than one type of gland in twenty-six patients as illustrated in Table III. This finding is significantly different than that of Ellison et al. [18] who found no multiple glandular involvement in 812 ulcers found in 20,000 consecutive autopsies. Of these twenty-six patients 50 per cent had functioning pancreatic tumors as evidenced by clinical hypoglycemia. This is a much greater incidence of functioning tumor than has usually been reported in the Zollinger-Ellison syndrome and may possibly be related to the multiplicity of endocrine involvement. In the remaining seventy-five patients in whom only one endocrine gland was described as abnormal only four additional cases of hypoglycemia occurred. Multiplicity of tumors

TABLE II
SUMMARY OF TABLE I

Total cases	107
With ulcer	101
Without ulcer	6
Ulcer with multiple endocrine tumors	26
Ulcer with parathyroid tumor	51
Single adenoma	13*
Multiple adenomas	12
Diffuse hyperplasia	15*
Unspecified	13*
Ulcer with pituitary tumor	28
Ulcer with pancreatic tumor	51
Islet cell carcinoma	21
Single islet adenoma	16
Multiple adenomas	9
Hypoglycemia (tumor not found)	2
Alpha cell hyperplasia	1
Acinar carcinoma	1
Unspecified	1
Functioning tumors	13
Non-functioning tumors	38
Ulcer with adrenal tumor	12

* Two patients had both single adenoma and hyperplasia.

TABLE III
PEPTIC ULCERATION WITH MULTIPLE ENDOCRINE DISEASE

Author	Sex and Age (yr.)	Parathyroid	Pancreas	Hypoglycemia	Pituitary	Adrenal
Wilder et al. [74]	M,40	Stones	+	+		
Gerstel [27]		+	+		+	+
Shelburne et al. [60a]	M,26	+	+	+	+	
Gordon et al. [29]	M,26		+			+
Cunningham et al. [13]	M,42	Stones	+	+		+
Furbetta et al. [26]			+	+	+	
Underdahl et al. [68]	F,50	+	+	+	+	
	M,36	+	+	+		
Moldawer et al. [46]	M,46	+		○	+	
Wermer [73]	F,39	+	+	+	+	
	F,34	+	+	+	+	
Baumgartner et al. [5]			+	+		+
Eiseman et al. [16]	M,39	+	+	+	+	
Ellison [17]	M,57		+		+	
McCormack et al. [45a]	M,48	+	+	+		
	F,57	+	+		○	+
	M,41	+	+		+	+
Donaldson et al. [14]	M,35	Stones	+		+	+
Fisher et al. [21]	M,37	Stones	+	+	+	+
Cope et al. [12]	M,45	+			+	
	F,43	+	+	○		
		+	+		+	
Zubrod et al. [78]	M,45	+	+		+	+
Waddell et al. [71]	F,40		○		+	+
Friedman [24]	M,50		+	+	+	+
Present case	M,38	+	+	○		+

TABLE IV

PEPTIC ULCERATION WITH PARATHYROID DISEASE

Author	Sex and Age (yr.)	Parathyroid				Pancreas	Hypoglycemia	Pituitary	Adrenal
		Single Adenoma	Multiple Adenomas	Hyperplasia (Multiple)	Unspecified*				
Wilder et al. [74]	M,40				+	+	+		
Herzenberg [34]					+				
Gerstel [27]		+				+		+	+
Shelburne [60a]	M,26	+				+	+	+	
Rogers [53]	M,36	+				○			
	M,53			+		○			
Rogers et al. [54]	M,68			+		Calcification			
Waife [72]	F,34			+					
	M,34			+					
	M,44		+						
Robinson et al. [52]	M,45			+					
Albright [2]	M,48			+					
Cunningham et al. [13]	M,42				+	+	+		+
Schmith et al. [59]	M,27	+							
	M,42	+							
Underdahl et al. [68]	F,50			+		+	+		
	M,36		+			+	+		
Echeles [15]	F,46	+							
Moldawer et al. [46]	M,46		+				○	+	
Wermer [73]	F,39				+	+	+	+	
	F,34				+	+	+	+	
Hellstrom [32]	M,22				+				
	M,48				+				
	M,29				+				
	M,48				+				
	F,47				+				
	F,47				+				
Carpenter et al. [9]	M,25	+		+					
Tsumori et al. [67]	M,10	+							
Eiseman et al. [16]	M,30		+			+	+	+	
McCormack [45a]	M,48			+		+	+		
	F,57			+				○	+
	M,41			+		+		+	+
St. Goar [61]	M,56		+						
	M,46	+							
	M,69		+						
	F,50		+						
Donaldson et al. [14a]	M,35				+	+		+	+
Fisher et al. [21]	M,37			+		+	+	+	+
Recant et al [50]	M,60		+						
Agna et al. [1]	F,37	+							
	F,32	+							
Cope et al. [12]	M,45		+					+	
	M,37			+					
	F,43			+		+			
	M,58				+				
			+			+		+	
			+			+		+	
Zubrod et al. [78]	M,45	+		+		+		+	
Headley et al. [31]	F,67	+							
Present case	M,38		+			+	○		+

* Parathyroid adenoma or hyperplasia were present but unspecified as to type or number of glands involved.

of the endocrine gland is probably considerably greater than is represented in Table III. In very few patients have the remaining glands been described as normal; in the majority of instances the other glands have not been examined either due to difficulties in clinical assay especially in view of the bizarre clinical history of many of these patients, or due to technical difficulty in demonstrating parathyroids at autopsy or failure to obtain permission to perform intracranial examination of the pituitary gland.

Table IV lists fifty-one patients in whom parathyroid disease was associated with peptic ulcer. More than half (twenty-seven patients) had adenoma or hyperplasia involving two or more parathyroids. Multiple adenomas were present in twelve and diffuse hyperplasia in fifteen. As hyperparathyroidism is usually due to a single adenoma in approximately 95 per

TABLE V

PEPTIC ULCERATION WITH PITUITARY DISEASE

Author	Sex and Age (yr.)	Pituitary Disease	Parathyroid	Pancreas	Hypoglycemia	Adrenal
Comroe [11]	F,19	Enlarged sella	Polyglandular disease described			
	M,57	Sellar erosion	but details not specified			
Gerstel [27]		Acidophil adenoma	+	+		+
Friedman [24]	M,50	Baso-eosinophil adenoma		+	+	+
	M,56	Basophil adenoma		+	+	
Graves et al. [30]	F,36	Enlarged sella	Polyglandular, details not given			
	F,42	Enlarged sella	Polyglandular, details not given			
	F,26	Enlarged sella	Polyglandular, details not given			
	F,41	Acromegaly	Polyglandular, details not given			
Shelburne et al. [60a]	M,26	Erosion sella	+	+	+	
Wilson et al. [75]	M,27	Acromegaly				
	M,45	Acromegaly				
Furbetta et al. [26]		Acromegaly		+	+	
Underdahl et al. [68]	F,50	Bitemporal hemianopsia	+	+	+	
Moldawer et al. [46a]	M,46	Enlarged sella	+	+	+	
Wermer [73]	F,39	Intrasellar tumor (x-ray film)	+	+	+	
	F,34	Acromegaly	+	+	+	
	F,32	Intrasellar tumor (x-ray film)				
Eiseman et al. [16]	M,39	Adenoma, unspecified type	+	+	+	
Ellison [17]	M,57	Basophil adenoma		+		
McCormack et al. [45a]	M,41	Chromophobe adenoma	+	+		+
Donaldson et al. [14]	M,35	Chromophobe adenoma	+	+		+
Fisher et al. [21]	M,37	Amphophil adenoma	+	+	+	+
Cope et al. [12]	M,45	Enlarged sella	+			
		Chromophobe adenoma	+	+		
		Chromophobe adenoma	+	+		
Zubrod et al. [78]	M,45	Chromophobe adenoma	+	+		+
Waddell et al. [71]	F,40	Abnormal bioassay		O		+

cent of patients [46a], this suggests that in these patients a basic difference in the type of pathology may exist. The significance of this finding is unexplained. Multiple adenomas were often demonstrated only after failure to relieve hyperparathyroidism by removal of what was originally believed to be a single adenoma. Perhaps some of the adenomas listed as single are actually multiple [39].

Twenty-eight cases of pituitary tumor with peptic ulcer are noted in Table v. In those cases in which histologic type is known there appears to be no cell type that may be considered as characteristically associated with ulceration. There were five chromophobe adenomas, two basophil adenomas; one eosinophil adenoma, and two amphophillic adenomas. In one patient in whom an eosinophil adenoma had been removed some years previously, a chromophobe adenoma was demonstrated at autopsy. Graves and Hodes [30] also found no characteristic cell type of pituitary tumor with ulceration. Pituitary bioassay studies by Waddell, Leonsins and Zuidema [71] have shown physiologic abnormality of the pituitary in this disease in which no gross nor histologic abnormality could be detected. For this reason plus the failure to examine the pituitary gland in many cases the figure given in Table v is also believed to be considerably below the probable incidence.

Fifty-one cases of peptic ulceration with concurrent pancreatic islet cell tumors are listed in Table VI. The histology of these tumors is shown in Table II from which it may be noted that slightly less than one-half of the islet cell tumors were malignant. Hypoglycemia was present in approximately one-fourth of the patients, the majority in those with multiglandular adenomas. Beta-cell tumors were identified in three patients but in most the tumors were believed to be of non-beta-cell

TABLE VI

PEPTIC ULCERATION WITH PANCREATIC TUMOR

Author	Sex and Age (yr.)	Pancreatic Disease	Hypoglycemia	Parathyroid	Pituitary	Adrenal
Wilder et al. [74]	M,40	Islet cell carcinoma	+	Stones		
Gerstel [27]		Adenoma of pancreas		+	+	+
Friedman [24]	M,50	Islet cell adenoma	+		+	+
	M,56	Islet cell adenoma	+		+	
Shelburne et al. [60a]	M,26	Three adenomas, tail	+	+		
Sailer et al. [57]	F,40	Large islet adenocarcinoma	○			
Gordon et al. [29]	M,26	Islet cell carcinoma				+
Amendola [3]	F,65	Islet cell adenoma	○			
Janowitz et al. [36a]	F,35	Islet cell adenoma	+			
Cunningham et al. [13]	M,42	Multiple islet adenomas	+	Stones		+
Furbetta et al. [26]		Not specified			+	
Underdahl et al. [68]	F,50	Not found, hypoglycemic	+			
	M,36	Islet adenoma	+	+		
Wermer [73]	M,41	Islet cell adenoma				
	F,39	Not explored; hypoglycemic	+	+	+	
	F,34	Multiple islet adenomas	+	+	+	
Baumgartner et al. [5]		Islet cell carcinoma	+			+
Zollinger et al. [76]	F,36	Multiple islet adenomas				
	F,19	Two adenomas, tail				
Eiseman et al. [16]	M,39	Beta cell adenoma and islet cell carcinoma	+	+	+	
Ellison [17]	M,61	Islet cell carcinoma				
	M,76	Islet cell carcinoma				
	F,57	Islet adenocarcinoma			+	
	M,55	Islet cell carcinoma				
	M,78	Islet cell carcinoma				
McCormack et al. [45a]	M,48	Beta cell adenoma	+	+		
	F,57	Islet cell carcinoma		+		+
	M,41	Beta cell adenoma		+	+	+
Busted et al. [8]	M,37	Islet cell carcinoma				
Cope et al. [12]	F,43	Islet cell adenoma		+		
		Islet cell adenoma		+	+	
		Multiple islet adenomas		+	+	
Priest et al. [49]	F,56	Islet adenoma, multiple	○			
Zubrod et al. [78]	M,45	Multiple islet adenomas		+	+	+
MacKenzie et al. [42]	M,29	Low grade islet carcinoma				
	F,54	Islet cell carcinoma				
Maynard et al. [44]	M,53	Islet cell carcinoma				
Thistlethwaite et al. [66]	M,55	Islet cell carcinoma				
	M,44	Islet cell carcinoma				
Zollinger et al. [77]	F,57	Acinar carcinoma				
	F,19	Islet cell adenoma				
	F,44	Multiple islet adenomas				
	M,50	No tumor found at resection				
Freidell et al. [23]	M,37	Islet cell tumor, lymph node				
Hendrick et al. [33]	M,28	Islet cell carcinoma				
	F,26	Islet cell adenocarcinoma				
Pender et al. [47]	M,39	Islet cell adenoma				
Summerskill [64]	M,35	Alpha cell hyperplasia				
Waddell et al. [71]	M,54	Islet cell carcinoma				
Present case	M,38	Islet cell adenoma	○	+		+
Forty et al. [22]	F,55	Islet cell adenoma				
Strøm [63]	M,32	Atypical beta adenoma				

TABLE VII

PEPTIC ULCER WITH ADRENAL TUMOR

Author	Sex and Age (yr.)	Adrenal Disease	Parathyroid	Pancreas	Hypoglycemia	Pituitary
Gerstel [27]		Nodular adenomatosis	+	+		+
Friedman [24]	M,50	Cortical adenomas (bilateral)		+	+	+
Gordon et al. [29]	M,26	Miliary adenomas		+		
Cunningham et al. [13]	M,42	Hyperplasia (cortex and medulla)	+	+	+	
Baumgartner et al. [5]		Hyperplasia (29 gm.)		+	+	
McCormack et al. [45a]	F,57	Hyperplasia	+	+		○
	M,41	Hyperplasia	+	+		+
Donaldson et al. [14]	M,35	Hyperplasia (cortex)	+	+		+
Fisher et al. [21]	M,37	Nodular hyperplasia	+	+	+	+
Zubrod et al. [78]	M,45	Cortical adenomas (multiple)	+	+		+
Waddell et al. [71]	F,40	Adenoma (left adrenal)		○		+
Present case	M,38	Multiple adenomas	+	+	○	

origin. In a number of instances the cell type was not identified in the original diagnosis; however, in subsequent review of the specimen in the light of the current interest in non-beta-cell tumors they were so identified after special staining. In view of the technical difficulties in staining, and with the knowledge of the diverse staining characteristics of the pituitary, it is possible to assume that the significance of the "non-beta-cell" may be exaggerated especially since the present evidence demonstrates that many of the islet cell tumors do indeed produce insulin. Fisher and Flandreau [21], for example, have reported an alpha-cell tumor in which the patient died of uncontrolled hypoglycemia. Lopez-Kruger and Dockerty [40b] reporting islet cell tumors in general found that only eight of forty-four tumors occurring in 10,314 consecutive autopsies caused hypoglycemia. Howard, Follis, Yendt and Connor [35] in a collective study of 398 islet cell tumors found 264 to be functioning. The former study is believed to be a truer reflection of incidence as the latter would undoubtedly be weighted by failure to diagnose and report many non-functioning tumors. Thus, it is not surprising that many pancreatic islet cell tumors do not produce insulin, and ulcerogenic properties should not necessarily be ascribed to such tumors because of failure to produce insulin. The role of glucagon as a cause of ulcer, although suspected by some [76], has not been confirmed. Recent studies have in fact shown that glucagon inhibits gastric secretion [14b,18].

In Table VII, the twelve patients with adrenal tumor or hyperplasia are described. In only one patient was a single adenoma found; in all others hyperplasia was generalized or adenomas were multiple and bilateral. Islet cell tumors were present in all but the patient with the single adenoma. This number agrees very closely with the 13.2 per cent involvement of the adrenal gland reported in autopsy material by Ellison et al. [18]. However, the twelve cases in this group were found among twenty-six autopsies so that the autopsy incidence of adrenal involvement was 42 per cent.

Although the term "ulcerogenic tumor of the pancreas" has become frequently used in current medical literature, no evidence other than coexistence of ulcer and pancreatic tumor can be drawn from the cases herein presented. If the tumor were truly "ulcerogenic" it would seem only reasonable to assume that removal of the pancreatic tumor alone should be followed by disappearance of the ulcer. No such case is included in the present series. In the relatively few patients who appear to have been cured, virtually total gastrectomy has been employed in almost every instance and would appear to be of greater importance than the excision of the pancreatic tumor. The concept of ulcerogenicity of tumors of the other endocrine glands has as yet not been widely advanced and no patients with ulcers have been cured upon their removal. In Table VIII evidence is presented to suggest that pancreatic tumors are in fact not ulcerogenic as

TABLE VIII

CASES RECURRING AFTER EXCISION OF ISLET CELL TUMOR OF PANCREAS IN WHICH NO RESIDUAL PANCREATIC TUMOR WAS PRESENT

Author	Sex and Age (yr.)	Clinical History
Amendola [3]	F,65	Perforated gastric ulcer four years after excision of islet cell tumor; no pancreatic tumor found at second operation
Janowitz et al. [36a]	F,35	Eight-year history of ulcer and hypoglycemia; hypoglycemia cured by excision of islet cell tumor, but ulcer continued to recur for 13 yr.
Machella et al. [41]	M,42	Marked hyperacidity (1142 cc. in 2½ hr.), 3 perforated jejunal ulcers, hypoproteinemia, sprue and multiple gastric operations for ulcer; ultimately cured by total gastrectomy; no pancreatic tumor ever found
MacKenzie et al. [42]	M,29	Resection of islet cell carcinoma with ulcer; gastric resection, re-resection, recurrence, gastrojejunal ulcer with gastrocolic fistula; died of hemorrhage; pancreas normal at autopsy
	F,54	Three-year history of diarrhea; perforated jejunal ulcer; hypersecretion; second perforated jejunal ulcer; excision tail and body of pancreas for islet cell carcinoma without improvement of ulcer; re-exploration for pancreatic tumor which was not found; recovered after high gastric resection
Thistlethwaite et al. [66]	M,44	Gastroenterostomy for ulcer; marginal ulcer six weeks later; vagotomy with one year relief; marginal ulcer at 14 mo.; gastric resection; marginal ulcer 8 mo. later; 90% gastric resection; continued hypersecretion; transthoracic vagotomy; lobotomy on two occasions for relief of pain; excision of islet cell tumor without improvement; ultimately died; no residual pancreatic tumor at autopsy
Waddell et al. [71]	F,40	Marked hypersecretion (5 to 10 L./day) with diarrhea for 2½ yr.; severe abdominal pain 9 mo.; resection large ulcer third portion of duodenum and pancreas (18 sections showed no tumor); died with recurrent multiple jejunal ulcers, and ulcers of stomach, duodenum and esophagus; adenoma of adrenal and abnormal pituitary on bioassay; no pancreatic tumor at autopsy
Zubrod et al. [78]		Wermer in discussion reports on a patient with recurrent ulcer who died many months after subtotal pancreatectomy for islet cell tumor; no additional pancreatic tumor was found at autopsy

demonstrated by brief clinical histories in eight patients. In these patients either excision of pancreatic tumor failed to cure the patient with an ulcer or all the components of the Zollinger-Ellison syndrome were present except for the presence of pancreatic tumor. In all patients proof of absence of residual pancreatic tumor was established.

CASE REPORT

The patient was a thirty-eight year old white male airline pilot admitted to Huron Road Hospital as an emergency because of severe abdominal pain with associated cramps and vomiting. Symptoms had been present for ten days and were of increasing severity. During the preceeding five years he had been intermittently treated for ulcer and melena had occurred on two prior occasions. Fourteen months previously a benign parathyroid adenoma had been excised at another hospital. Details of the clinical course at this time are lacking. On physical examination he appeared obese, pale and in acute distress. Blood pressure was 110/70 mm. Hg; pulse, 80 per minute; respirations, 22 per minute. There was a well healed scar over the anterior edge of the left sternocleidomastoid muscle. A few small, non-tender nodes were palpable in the right supraclavicular region. Heart and lungs were considered normal; bilateral gynecomastia was present. The abdomen was very obese and soft. Tenderness of the epigastrium was present on palpation. The spleen, liver and kidneys were not enlarged to palpation. Bowel sounds were audible but diminished. There were no hernias. Rectal examination revealed no abnormalities and no gross blood was noted. Moderate pitting edema of both legs was present. Laboratory data revealed a moderately severe anemia with

hemoglobin of 8.2 gm. per cent with microhematocrit of 26 per cent. Leukocytosis of 17,850 per cu. mm. with 79 per cent polymorphonuclear neutrophils, 19 per cent lymphocytes, 1 per cent eosinophils and 1 per cent monocytes was found. Urinalysis was within normal limits but serum proteins were slightly depressed with an albumin of 3.7 gm. per cent and globulin of 1.35 gm. per cent. The sedimentation rate was 96 mm. per minute and the prothrombin time 16 seconds with a control of 12 seconds. Alkaline phosphatase was 0.05 Bodansky units; cholesterol, 73 mg. per cent. Serum electrolytes were normal. Calcium was 9.7 gm. per cent and phosphorous 3.05 gm. per cent. Gastric analysis showed 20 units of free HCl and a total of 100 units. The stool was positive for blood on three examinations. Blood smears showed a cell diameter of 7.5 μ with mean corpuscular volume of 95 cu. μ. and mean corpuscular hemoglobin concentration of 23.5 per cent with a volume index of 1.1.

A flat roentgenogram of the abdomen revealed no abnormalities as did intravenous pyelograms. Roentgenogram of the chest revealed no abnormalities. Upper gastrointestinal roentgenograms with small bowel studies suggested ulceration extending from the duodenum into the jejunum. Barium enema showed no abnormalities. He failed to improve on medical therapy consisting of antacids, sedation, corticoids and blood replacement and underwent exploration seventeen days after admission. An inflammatory mass was found in the jejunum just distal to the ligament of Treitz. (Fig. 1.) This area was excised and found to contain a large ulcer and an area of aberrant pancreatic parenchyma which was histologically normal on frozen section. Primary resection and anastomosis was performed in this area with considerable technical difficulty due to the proximity to the mesenteric root. On the third postoperative day he became severely distended and the wound began to drain large amounts of serosanguineous fluid. He died the following day with clinical evidence of fulminant, generalized peritonitis.

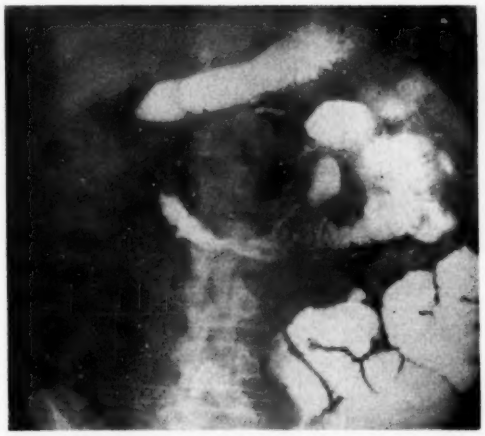

FIG. 1. Upper gastrointestinal roentgenograms, which were interpreted originally as demonstrating regional enteritis, on review after surgical demonstration of ulcer demonstrate a large ulcer defect near the ligament of Treitz.

At autopsy generalized peritonitis was attributed to failure of the line of jejunal anastomosis to heal. No additional ulcers were present. An islet cell adenoma was found in the body of the pancreas (Fig. 2) and a parathyroid adenoma found on the right (Fig. 3) which was histologically similar to the parathyroid adenoma removed previously. (Fig. 4.) Multiple cortical adenomas were present in both adrenals (Fig. 5) and hypospermia was noted in the testes. Permission for examination of the pituitary was not granted. The ulcer found in the surgical specimen (Fig. 6) was not unusual except for the presence of a severe, inflammatory arteritis in the immediate vicinity of the ulcer. (Fig. 7.)

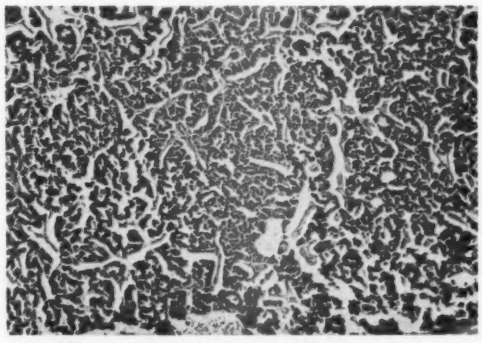

FIG. 2. Islet cell adenoma of the pancreas.

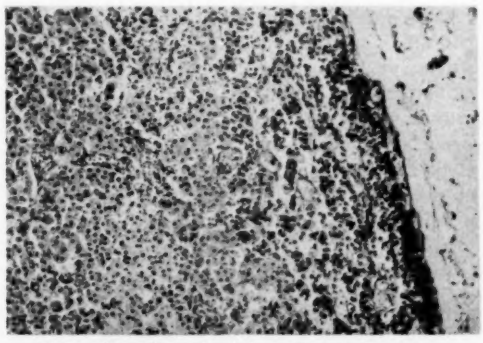

FIG. 3. Parathyroid adenoma found at autopsy.

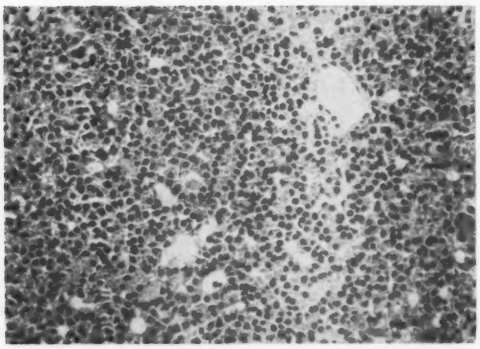

FIG. 4. Surgical specimen of the previous parathyroid adenoma.

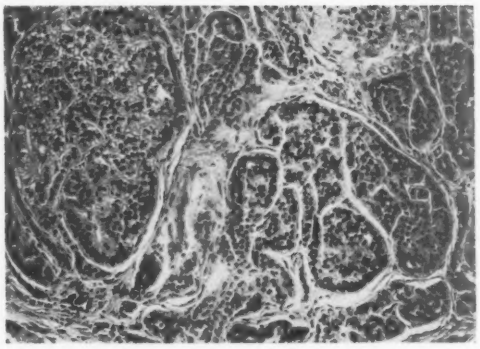

FIG. 5. Adrenal adenomas.

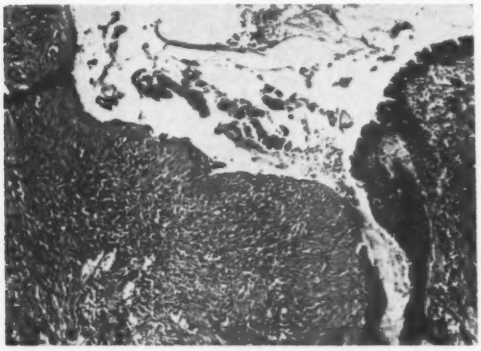

FIG. 6. Surgical specimen of the jejunal ulcer.

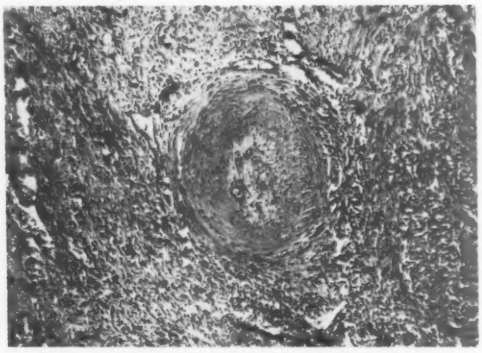

FIG. 7. Arterial lesion in ulcer base.

COMMENTS

Peptic ulceration has been reported in 101 patients who had associated tumors or hyperplasia of the pituitary, parathyroid, pancreas, and/or adrenal. Hyperplasia is the predominant change in the endocrine glands and suggests that possibly a common stimulus exists for all of the changes and that no single gland should be considered as the etiologic agent in peptic ulcer. Although each of the aforementioned endocrine glands is known to have a stimulating effect upon the gastric mucosa no proof of a causal effect in ulceration exists. Peptic ulcer occurs in approximately 2 per cent of the entire population [*37*] and in more than 4 per cent of men beyond the age of twenty years so that the possibility of chance association with an endocrine tumor is real. In the opinion of Black and others [*7,68*] the incidence of ulceration with endocrine tumor is considerably greater than the general incidence but the reported series are too small for statistical verification.

Parathormone has been shown to increase the secretion of pepsin [*19,28,56,58*] but reduces total gastric volume and acidity. Perfusion studies of the canine esophagus [*51*] suggest that pepsin when activated by gastric juice will uniformly produce ulceration but that gastric juice from which pepsin has been removed will not cause an ulcer. Many symptoms of hyperparathyroidism mimic those of peptic ulcer and have led to clinical confusion in diagnosis [*50,61,62*]. Treatment of ulcer with milk and alkali in patients with coexisting hyperparathyroidism has in some cases led to acute parathormone intoxication [*6,9,38,50,61*] and has caused at least two deaths [*61,72*]. The function of the pancreas in promoting gastric secretion is not clearly understood. The studies of Poth et al. [*48*] have shown that diversion of pancreatic secretion from the intestinal tract uniformly causes ulceration in a

large percentage of animals whereas complete removal of the pancreas is only rarely followed by ulcer. Hypoglycemia has been shown to increase gastric secretion when the blood sugar falls below 70 mg. per cent. Cortisone increases gastric volume and free acid [*60b*] while pituitary stalk section has been followed by a fall in gastric secretory volume with an increase in acidity without significant change in pepsin [*36a*]. Some [*71*] believe that ulceration in this disease is a manifestation of a Cushing type ulcer originating from stimulation of the hypothalamus and that all the endocrine dyscrasias are secondary to this hypothalamic origin. However, vagectomy has been uniformly unsuccessful in treatment of this type of ulceration.

Wermer [*73*] believes that ulcer with coincident endocrine adenomatosis is due to the presence of a dominant autosomal gene which is in itself causal of both. In two other reports [*46a,47*] a familial relationship was shown; however, in 100 cases listed in Table 1 there is no known hereditary aspect. Thistlethwaite and Horwitz [*66*] postulate that the endocrine adenomas are carcinoids and that serotonin is the ulcerogenic agent. At present physiologic data to support this concept are lacking.

Echeles [*15*] stresses the importance of the vascular changes in the formation of ulcer. Marked vascular changes similar to periarteritis were present in the vessels adjoining the jejunal ulcer in our case. The significance of the vascular lesion is obscure and its relation to the general syndrome cannot be ascertained at this time.

Many of the more recent publications have stressed the importance of severe diarrhea in these cases [*23,31,42,44,47,49,64,66,69,72*]. Five patients have died as a direct result of severe diarrhea and uncontrollable hypokalemia [*49,69,70*]. Diarrhea is believed to be due to inactivation of pancreatic enzymes by the extremely acid pH produced by gastric hypersecretion. Malabsorption defects similar to sprue have been described [*44,64,71*] as has been severe hypoproteinemia [*4,41,72*]. Steroids have been effective in some cases in controlling diarrhea and hypoproteinemia but occasionally have been followed by perfcration of an ulcer. Total gastrectomy has successfully restored the serum proteins in one case.

The Zollinger-Ellison syndrome as originally described consisted of extreme gastric hypersecretion, peptic ulceration, frequently in atypical location, and the presence of a non-insulin producing islet cell tumor of the pancreas [*76*]. In addition to this triad should be added the symptom of diarrhea which is present in a high percentage of patients. Malabsorption and hypoproteinemia are less common but do occur. Adenomas of the parathyroids occur as frequently as do adenomas of the pancreas. Adenomas or hyperplasia of the pituitary and adrenal glands are slightly less common than those of the parathyroids and pancreas in this compilation but this is believed to be due to the method of examination rather than indicating any real difference in incidence. The islet cell tumor in many instances does produce insulin and the significance of the "non-beta-cell" is questioned. The suggestion is made that the syndrome be modified to the following concept: (1) extreme gastric hypersecretion; (2) peptic ulceration, frequently in atypical location; (3) diarrhea; (4) multiglandular adenomas or hyperplasia, involving the pituitary, parathyroid, pancreas and adrenal; and (5) endocrine adenomas are probably concomitant portions of a composite syndrome and are not in themselves ulcerogenic.

SUMMARY AND CONCLUSIONS

1. One hundred seven cases including 101 patients with peptic ulceration in whom adenoma or hyperplasia involving one or more endocrine glands was found have been collected and are reviewed.

2. In patients with peptic ulcer the parathyroid glands were found to contain adenomas or hyperplasia as frequently as was the pancreas.

3. Parathyroid tumors were found to be multiple in more than one-half of the cases in which tumor was associated with ulceration.

4. Hyperinsulinism was present in one-fourth of all cases and one-half of cases in which involvement of more than one system of endocrine glands was present.

5. One-half of the patients in this series upon whom postmortem examinations were performed (thirteen of twenty-five) showed multiglandular involvement.

6. Pancreatic islet cell tumors showed a high percentage of malignancy. (Twenty-two of fifty-one.)

7. Tumors of the other endocrine glands appeared to be benign.

8. No "ulcerogenic" relationship of endocrine tumor to peptic ulcer has been shown to exist. Evidence is presented to suggest that in fact it does not exist.

9. The possibility that the coexistence of peptic ulceration and endocrine tumor is merely a chance relationship can be neither proved nor disproved by the present data.

10. Modification of the Zollinger-Ellison syndrome in the light of increasing clinical reports of such cases is suggested.

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Median Sternotomy Using a Transverse Submammary Skin Incision

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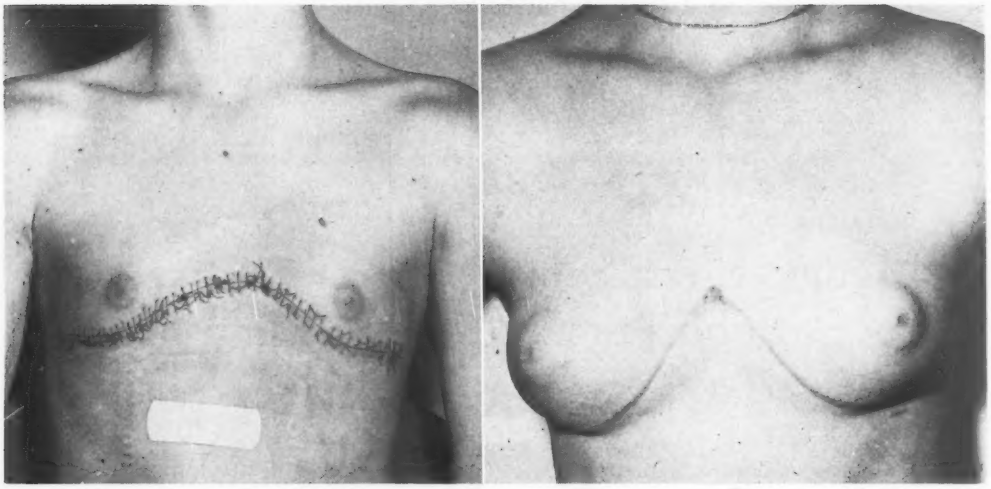
THE cosmetic disadvantages of the usual median sternotomy have restricted its full acceptance, even by those who recognize its many advantages. Some surgeons have tried to improve the cosmetic effect by beginning the longitudinal incision a short distance below the suprasternal notch, sometimes adding an additional transverse arm to form a T [2]. Others have continued to use bilateral intercostal thoracotomy with transverse sternotomy for patients who are good risks for surgery and seem able to accept some additional morbidity as the cost of a less conspicuous scar [3]. For the past year we have used with satisfaction an approach which preserves the advantages of longitudinal sternotomy while providing a relatively inconspicuous scar.

TECHNIC

A submammary skin incision is made similar to that for bilateral thoracotomy in the fourth intercostal space. (Fig. 1A and B.) The incision is placed below the areolae on the inferior aspect of the breast, but cephalad to the junction of breast and the wall of the chest. The central portion of the incision is arched toward the sternal notch, but not so acutely as to form a lower peninsular flap of questionable viability. Flaps are developed by dissection at the level of the superficial pectoral fascia. The superior flap is raised to expose the suprasternal notch, with minimal dissection of the lateral portions of the flap. The central portion of the inferior flap is raised to a point several centimeters below the xiphoid process, again with minimal lateral dissection. The sternum is split longitudinally according to usual methods. In infants and young children, we use heavy scissors. Bone shears may be necessary in older children, and a Lebsche knife is customarily used for adults. We generally form a notch on one side of a heavy sternum with a corresponding projection from the other side to assure greater stability by way of this mortise. Some have advocated a motor driven saw for convenience or as a presumed safeguard against shock. We have occasionally used this in adults, but consider its advantages insignificant.

During any sternotomy one must bear in mind the need of avoiding trauma to a large heart or to the left innominate vein and its tributaries. After separation of the sternum, it is customary to spend several minutes achieving hemostasis by means of bone wax and judicious electrodesiccation of multiple small bleeding points on the inner and outer aspects of the sternum. The region of the divided interclavicular ligament is a notorious source of troublesome oozing in sternotomy; one can expose this area quite satisfactorily by retracting the upper flap.

The pericardium is opened longitudinally from the diaphragm to the aortic reflection. At the conclusion of the cardiac repair, free drainage of the pericardial space into the right pleural space is provided by resection of a large window of pericardium and pericardial pleura down to the phrenic nerve. Great care



1A 1B

FIG. 1. A, fifteen year old boy three days after operative correction of pectus excavatum and valvular pulmonary stenosis. Exposure of the upper sternum was excellent despite the wide angle at the center of the incision. B, twelve year old girl six months after closure of ventricular septal defect using median sternotomy. Note acute central angle of incision in contrast to A. This resulted in some impairment of circulation to the tip of the lower flap. In both patients the highest portion of the scar is well below the suprasternal notch.

is taken to effect hemostasis in vessels severed in this process. The superior half of the pericardium is loosely approximated and the right pleural space is drained by means of a large intercostal tube placed in the posterior axillary line. The sternum is tightly approximated with heavy non-absorbable sutures. The flaps are held to the pectoral fascia by a few fine silk sutures and drainage beneath the flaps is generally provided by a small multiperforated catheter brought out through a stab wound below the incision and connected to mild suction. Skin closure is with interrupted fine silk sutures.

COMMENTS

We heartily endorse the claimed merits of the sternum splitting incision [1]. It spares the lung from exposure and trauma, permits improved respiratory function in the postoperative period, provides good exposure, conserves time, and is associated with minimal hemorrhage if care is taken to secure small vessels in the periosteum. The objections to the usual longitudinal incision are the unsightly scar especially in women, and the slightly less ample access to certain areas of the mediastinum as compared to the bilateral thoracotomy approach. Moreover, there is occasional accumulation of blood in the anterior mediastinum.

A transverse submammary incision results in a most acceptable scar without detracting appreciably from the listed advantages of the median sternotomy. Wide drainage of the pericardium into the right pleural space with placement of a large thoracostomy tube minimizes the tendency for accumulation of blood in the pericardium or retrosternal area. We concede some restriction of access by the sternotomy approach and in lesions requiring particularly wide exposure through the right atrium, as in atrioventricular canal, we prefer a right lateral thoracotomy.

This skin incision for median sternotomy requires more operative time than the usual midline incision. In those instances in which risk is great and operative time should be minimized, we may employ the midline skin incision even in women. It is possible to limit the upper extent of this incision to a point 3 to 4 cm. below the sternal notch and by retracting the upper flap achieve adequate access to the manubrial area without the necessity for a T incision. In most instances, however, when median sternotomy is elected,

the transverse skin incision described here seems preferable.

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Local Anesthesia for Inguinal Herniorrhaphy

A SURVEY OF FIFTY PATIENTS

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LOCAL anesthesia is not regularly used for inguinal herniorrhaphy; yet it possesses certain advantages, especially for the aged patient and the patients who are poor risks for surgery. The technics for local anesthesia most often described for this operation are not, in our experience, the most suitable methods.

We have reviewed both the hospital records and questionnaires submitted to fifty consecutive patients undergoing hernia surgery under local anesthesia at the West Roxbury Veterans Administration Hospital. The data obtained, as well as the method of local anesthesia used, is presented herein.

MATERIAL AND METHODS

During the six month period from October 1, 1958 through April 1, 1959, sixty-three inguinal herniorrhaphies were performed upon fifty-five patients. Fifty of these patients underwent fifty-eight herniorrhaphies under local anesthesia. The remaining five patients underwent other operative procedures simultaneously, such as the repair of associated umbilical or incisional hernias, for which other types of anesthesia were used. These five patients have been excluded from this study.

The charts of the fifty patients undergoing inguinal herniorrhaphy with local anesthesia have been reviewed. All patients were men. Their ages ranged from twenty-one to eighty-three years with an age distribution as outlined in Figure 1. Among the fifty-eight herniorrhaphies performed, there were fifty-seven inguinal hernias and one femoral hernia. The inguinal hernias included one sliding, three recurrent, five combined (pantaloon), twenty-four direct, and twenty-four indirect hernias. Of the fifty-eight hernias, twenty-seven were on the right side and fifteen were on the left side. Eight patients had bilateral hernias.

The repairs were not standardized. Each herniorrhaphy was carried out by the method which seemed most appropriate at the time of surgery. Bassini repairs were preferred, saving Cooper ligament repairs for recurrent or large direct hernias. The herniorrhaphies are classified as follows: Bassini (conjoined tendon or transversalis fascia to the inguinal ligament, and external oblique closed over the cord) forty-five, Halsted (same, except for transplantation of the cord above the external oblique fascia) six, Cooper ligament (transversalis fascia to superior pubic ligament) seven. All bilateral herniorrhaphies were performed in two stages, usually four to seven days apart. All operations were performed by surgical residents. Each procedure was supervised by a senior resident or a member of the attending staff.

All patients were premedicated. This was not standardized, but usually consisted of Nembutal® 100 mg., and morphine 10 mg. or Demerol® 100 mg. Larger amounts were

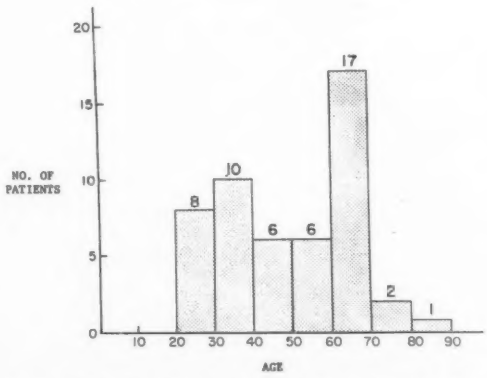

FIG. 1. The age distribution for fifty patients undergoing herniorrhaphy with local anesthesia.

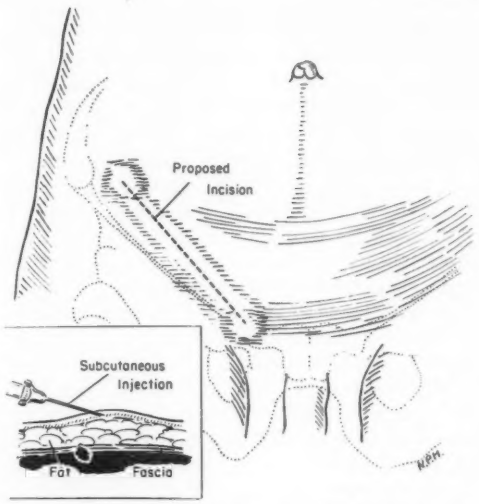

FIG. 2. Intradermal and subcutaneous infiltration is carried out between the two initial skin wheals and along the line of the proposed incision.

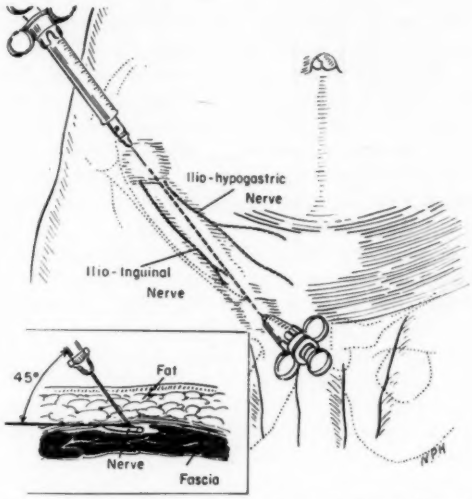

FIG. 3. Sub-fascial infiltration is carried out through the initial skin wheals. The regional nerve supply and the area about the pubic tubercle are thus anesthetized.

avoided to allow the patient to cooperate fully, as well as to permit adequate evaluation of the anesthetic technic. The dosages were frequently reduced for the older patients.

An anesthesiologist or nurse anesthetist was in attendance for each case. The usual anesthesia chart was kept and pulse, blood pressure and respiration were recorded in most instances. An intravenous infusion of 5 per cent dextrose was given during the operation; an attempt was made, however, to hold the amount administered to less than 500 cc. to avoid postoperative difficulty in voiding.

The same anesthetic solution was used for every patient regardless of age or risk. This consisted of a mixture of: 30 cc. of 1 per cent Xylocaine® (lidocaine) with epinephrine 1:100,000, 30 cc. of normal saline for injection, and 4 cc. (two ampules) of 1 per cent Pontocaine® (tetracaine). The resultant solution of 64 cc. contained: 300 mg. of Xylocaine (approximately 0.5 per cent), with 40 mg. of Pontocaine (approximately 0.06 per cent) and 0.3 cc. of epinephrine 1:1000.

No supplemental inhalation or intravenous anesthesia was used, as cooperation is helpful in gaining adequate anesthesia. Patients thus treated tend to become disoriented and lose their ability to cooperate. When this occurs a change to full general anesthesia may be required. An intravenous opiate or barbiturate in small doses may be useful, however, if premedication has worn off or if the patient is severely apprehensive. This was thought to be indicated in only four cases during the present series of fifty-eight herniorrhaphies.

TECHNIC OF INFILTRATION

Using a short No. 25 needle, a skin wheal is raised 1 inch medial to the anterior superior spine of the ilium. Another wheal is raised just medial to the pubic spine. These two skin wheals are then connected with intradermal infiltration using a No. 22 needle 3 inches long and from 5 to 10 cc. of solution. (Fig. 2.) The subcutaneous fat is then infiltrated with from 5 to 20 cc. or more of the anesthetic mixture, according to the obesity of the patient. Next, the external oblique aponeurosis is pierced by inclining the syringe at 45° so that the needle enters via the lateral skin wheal and along the line of the proposed incision. As the needle is felt to pierce the fascia, 2 or 3 cc. of solution are injected sub-aponeurotically. (Fig. 3.) This point corresponds to the most lateral point at which the external oblique fascia is usually opened, and in a remarkably high percentage of cases the solution will be found to be bathing the ilio-inguinal and ilio-hypogastric nerves as they emerge through the internal oblique muscle to lie beneath the external oblique aponeurosis. No more solution is injected at

this point since the nerves may be injected later under direct vision if necessary. The final injection is deep to the most medial wheal where from 3 to 5 cc. of solution are placed in the region of the external ring and along the periosteum from the pubic spine downward for a short distance along the superior pubic ligament. (Fig. 3.) Aspiration is not required during the injections as long as the needle point is kept in motion.

The incision may be made immediately after the infiltration is completed, although allowing a few minutes for spreading of the solution reduces discomfort. The ilio-inguinal and ilio-hypogastric nerves are infiltrated under direct vision if it is seen that they are not involved by the edema of the injection. The fascia should be incised with care until the adequacy of the anesthesia in this region can be assessed.

For the remainder of the procedure, the surgeon must be alert for any signs of discomfort. This is usually manifested first by a slight motion of the leg on the operative side, or the patient may complain of a "pulling sensation" or a deep pain "like a toothache." If the surgeon suspects pain, supplemental doses of the anesthetic solution should be added immediately. The instrument nurse is instructed to pass the syringe automatically at the slightest evidence of discomfort. No greater interruption is required than for the handling of any other instrument and the procedure can continue painlessly. Such small supplementary increments rarely require more than 1 cc. of solution.

With experience, the surgeon learns the areas where such supplementary anesthesia may be required. These, in order of dissection, are: (1) below the shelving edge of Poupart's ligament in the region of the femoral vessels (careful aspiration should be performed before injection); (2) in the substance of the cord at the internal ring; (3) in the peritoneum at the neck of an indirect sac. In the presence of large sacs, where intraperitoneal manipulation may be required, 5 cc. of solution placed directly intraperitoneally gives excellent topical anesthesia for the peritoneum and involved viscera; and (4) supplementary anesthesia is occasionally required about the pubic tubercle as the repair is begun if the initial injection did not adequately reach this area.

The importance of adding supplementary dosages of anesthesia as soon as discomfort is suspected, cannot be over-emphasized. If this is not done, the patient soon becomes restless and apprehensive as the surgeon persists in his dissection. Thin patients may require no further anesthetic injection after the initial infiltration. Others may require occasional small supplementary injections during the early part of the procedure. Much depends on the care exercised with the initial infiltration.

The amount of solution required is a function of the surgeon's experience and the patient's obesity. Although the same amount of the anesthetic mixture was mixed for each operation, the total 64 cc. was rarely used and then only in obese patients. Twenty to 40 cc. of solution was usually sufficient, and several patients required less than 20 cc.

Postoperatively, the patients were not restricted as to either fluid or diet. The Pontocaine utilized in the anesthetic solution extended the anesthesia time up to six hours for some patients. This apparently decreased the amount of postoperative opiates required, but certain of the patients walked about freely without pain during this period. These patients were noted to have increased pain after the anesthesia had disappeared. For this reason, subsequently, bed rest was advised, except for voiding, until sensation had returned to the operative site. Thereafter, ambulation was encouraged.

RESULTS

A questionnaire was sent to each patient postoperatively to aid in evaluating the subjective reaction to the local anesthesia. Each veteran was asked to classify his surgical experience as to degree of pain as "no pain," "slight pain," "moderate pain," to "severe pain." Each was also asked to indicate whether he would prefer another type of anesthesia if further surgery of a similar sort needed to be carried out.

Replies were received from forty-six of the fifty patients queried (a 92 per cent response). Twenty-three (50 per cent) experienced "slight pain," and the remaining twenty-three felt "no pain" during the procedure. All patients seemed satisfied with the method used, as none indicated that they would prefer a different type of anesthesia for subsequent surgery.

From the surgeons' viewpoint, the anesthesia was adequate in all cases, including the younger patients, several of whom had shown considerable preoperative apprehension.

No reactions were encountered suggestive in any way of drug sensitivity to the local anes-

thetic agents used. No suggestion of systemic epinephrine effect was seen in any patient. One patient, a sixty-nine year old male with hemiplegia secondary to a cerebral vascular accident, was disoriented during surgery. This was accompanied by dilated pupils and cutaneous flushing. The reaction was presumed to be due to an idiosyncrasy to, or an inadvertent overdosage of the scopolamine given as part of his preoperative medication.

Vital signs had been charted on the anesthesia records for fifty of the fifty-eight operations. These remained remarkably stable with little change in pulse, blood pressure, or respiration. Twenty-two of these patients (44 per cent) showed 10 or less points between the highest and lowest systolic pressures; forty-two (84 per cent) showed 20 or less points of difference, and 47 (97 per cent) showed thirty or less points between the highest and lowest systolic readings.

Urinary catheterization was required for only one of the patients, which was probably unnecessary as only 300 cc. of urine were obtained.

Postoperative complications included a single case of presumed pulmonary atelectasis, diagnosed by physical signs and fever. This cleared within forty-eight hours on a program of coughing and ambulation without antibiotics.

There were three wound complications which required hospitalization beyond the usual sixth or seventh postoperative day. These included a wound hematoma which was evacuated with subsequent satisfactory healing. There were two wound infections. Both involved the entire subcutaneous space above the deep fascia. Staphylococci were isolated from both. These occurred in the forty-seventh and forty-eighth patients of the series. The operations were performed two days apart. No cause or break in technic could be determined to account for these infections. The rate of wound complications does not differ significantly from that observed in this hospital for herniorrhaphy.

Surgeons in the United States make use of local anesthesia only infrequently for major surgery. Local anesthesia is usually reserved for the patients who are the poorest risks for surgery. Difficulties which arise because of lack of experience with methods of administering local anesthetic discourage further usage.

Glover [*1*], in a recent article, has stressed the need for including experience with local anesthetic methods during surgical training. In support of this view, I would like to make three points: (1) local anesthesia is without question the safest available technic, (2) any surgical procedure *can* be carried out using local anesthesia (a point which may be of importance in emergency, disaster, shock, old age, debilitation, or in the absence of trained anesthetists, and (3) local anesthesia is an extension of the surgical procedure (indeed, often an integral part of that procedure), and as such its administration should be the concern of the surgeon.

Inguinal herniorrhaphy is ideally suited to infiltration technics. The methods usually described are modifications of that originally described by Braun [*2*] and later modified by Labat [*3*]. These methods utilize a combination of regional and field blocks with local infiltration and have not proved satisfactory in our hands. Large amounts of anesthetic solution are required using 1 gm. or more of Procaine or its equivalent, and often failing to give adequate anesthesia.*

By a process of gradual modification the technic described in this paper was evolved and it has proved satisfactory in our hands. No originality is claimed for it and it is suspected that a similar method is used by most surgeons who use local anesthesia frequently in hernia repair.

A paper by Cushing [*4*] which appeared in 1900 describes forty-nine cases of inguinal herniorrhaphy performed under local anesthesia. Cocaine (0.1 per cent) was used, as neither Procaine nor epinephrine were available at that time. The anatomy of the nerve supply of the inguinal region was clarified during this series and presented, illustrated with his own drawings. Cushing was impressed with the many advantages which local anesthesia gave

* Although 1 gm. of Procaine is often stated to be the maximum permissible dosage, it seems safe, with experience, to use far larger dosages.

Dr. E. A. Ryan of Shouldice Surgery, Toronto, Ontario, has described, in a direct communication, the method of administering local anesthetic used in over 23,000 herniorrhaphies performed at that clinic. Procaine (2 per cent) is used routinely. Up to 4 gm. or more are injected, by direct infiltration, into the operative site. Convulsive movements have been encountered, but these are prevented by the use of relatively large amounts of Nembutal (pentobarbital), as a preanesthetic sedation (0.2 gm or more).

Earlier experiences based on 2,874 herniorrhaphies performed at Shouldice Surgery have been summarized in detail by CAMPBELL, E. B. *Canad. M. A. J.*, 62: 364, 1950.

over the crude technics for the administration of general anesthesia of his day. He continued to use local anesthesia widely in his subsequent neurosurgical endeavors.

Cushing's technic of anesthetization was similar to that which we have found most suitable and is similar to that described by Glover in the article alluded to previously [1]. This consists essentially of local infiltration along the proposed incision with infiltration of the nerve supply under direct vision.

As Cushing clearly demonstrated sixty years ago, the chief value of local anesthesia is the low operative risk associated with its use. Further advantages are the low incidence of postoperative respiratory complications common with general anesthesia and neurological sequelae, chiefly headache, following spinal anesthesia. The need for postoperative catherization for urinary retention is strikingly low. The "stormy emergence" of general anesthesia, a possible agent productive of stress on the wound and subsequent recurrence, is avoided.

Advantages during operation include the patient's cooperation which is of assistance in assessing the size and situation of the sac and surrounding structures. The relatively bloodless field secondary to the use of epinephine is a minor aid.

There are two major disadvantages to the use of local anesthesia in herniorrhaphy: first, the patient inevitably feels some pain. With adequate premedication, however, and with increasing experience of the surgeon this should become negligible; the second disadvantage, often the hardest for the surgeon to accept, is the inconvenience and demand imposed upon the surgeon by the method. Not only is the institution of anesthesia the responsibility of the surgeon, but the constant maintenance of anesthesia as well, with the occasional interruptions of the surgical procedure which may be required for this. Further, a degree of gentleness of manipulation and retraction during the surgery is required which some surgeons will be unwilling to meet.

Minor disadvantages include lack of relaxation as compared with spinal anesthesia. This does not prove annoying and actually seems to permit a more accurate appraisal of the tissues, preventing undue traction on the repair following the reappearance of normal muscle tone as when spinal anesthesia is used.

Obesity is only a relative contraindication. In the obese patient, spinal anesthesia is probably the method of choice. We found, however, as our experience increased, that we were able to achieve adequate anesthesia even with the most obese patient of the present series.

We have been impressed with the Xylocaine-Pontocaine-epinephrine solution used for this series of herniorrhaphies. It appears to be rapid in onset, potent, and long-acting (up to six hours) even when small amounts are used, despite the low concentrations of the drugs. I believe, however, that any of the commonly employed local anesthetic agents will give satisfactory results in experienced hands.

Success, using local anesthesia, is determined primarily not by the drug used but by the interest and experience of the surgeon. Labat stated many years ago, "The scope of operations capable of being performed by means of regional anesthesia is dependent on many factors which can all be reduced to the simple expression, *experience of the surgeon*."

SUMMARY

Fifty-eight consecutive herniorrhaphies under local anesthesia are analyzed with a consideration of the methods used and the results obtained.

Our experience indicates that local anesthesia can be as satisfactory a method as either general or spinal anesthesia, and has certain advantages over these methods.

The major disadvantage of local anesthesia is the added demand placed on the operating surgeon.

Experience in the use of local anesthesia is the single most important factor for its success.

Acknowledgment: I wish to express my appreciation to Dr. Richard Warren for his encouragement in compiling this survey; and to the various surgical residents of the Peter Bent Brigham Hospital for their interest in the use of local anesthesia for this series of operations.

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Surgery Court Cases

A Review of Two Cases

HOWARD NEWCOMB MORSE,* *Atlanta, Georgia*

BAST VS. MARSDEN

Supreme Court of Wisconsin

260 Wis. 459, 50 N. W. 2d 686

The surgeon treated the patient for an injury to his right arm. Six years later the patient consulted the surgeon with a complaint that the arm was stiff and sore. A roentgenogram showed an exostosis. It was the result of the patient's occupation and his using a hammer and saw, and it disturbed the normal function of the patient's arm.

The surgeon operated on the arm to remove the exostosis. In the course of the operation, the surgeon, after locating the position of the exostosis by use of the roentgenogram, made an incision just through the skin with the sharp edge of the scalpel, and he found an exostosis of the right radius with several spurs about 1 inch below the head of the radius and elevated about ¼ inch above the medial border of the radius and extending along the radius about 1 inch. Without using the sharp edge of the scalpel the surgeon separated the muscles immediately beneath the skin without disturbing their structure at all. The first muscle it was necessary to disturb structurally was the supinator, located directly over the exostosis, and this muscle was separated in the direction of its fibers, which was at right angles to the incision, to secure exposure of the exostosis. The fibers were not cut, but were separated with the blunt end of the scalpel, so as to avoid disturbing the function of the muscle as little as possible.

The surgeon's intention was to avoid exposing the deep radial nerve if possible, and if it came in his view, to retract it and stay away from it. If it had been in the cleavage of the supinator muscle it would have been in the surgeon's field of view and he would have seen it; but he did not see it. The absence of the nerve from his view, as he dissected through the supinator muscle, indicated to the surgeon that the nerve was not in the path of the operation.

During the operation the surgeon did not know that the deep branch of the radial nerve had been injured and nothing that occurred during the operation led him to believe that it had. When he did not see the nerve in the course of the operation he assumed it was retracted with the portion of the supinator muscle which was held aside by retractors. The asistant surgeon held the retractors in the position in which the surgeon had placed them, but the assistant surgeon was not so situated that he could see in the wound or see the exostosis.

The day after the operation there was swelling at the site of the operation which persisted for a week and weakness of the patient's hand which the surgeon attributed to the swelling and trauma incident to the operation. When that weakness persisted the surgeon did not conclude the nerve had been severed, but

* Counsellor at Law of the Supreme Court of the United States of America.

believed it was due to temporary swelling or trauma, or bruising to the nerve.

Two months after the operation, the patient was examined by another surgeon (a neurosurgeon) and three physicians. The neurosurgeon diagnosed the patient's trouble as an injury to the interosseous branch of the radial nerve. He operated on the patient for the purpose of exploring that nerve. He found the nerve was interrupted and sutured the ends. The previous scar was excised and the scar tissue was followed down between the muscles running down from the region of the elbow. This scar tissue was removed to expose the ends of the posterior interosseus nerve, down to the supinator brevis muscle. By further dissection the lower portion of the nerve was found but not in its usual position, and was found to be completely interrupted. There were two ends with scar tissue between them, and on the upper portion of the nerve there was a neuroma. The neuroma was removed by the neurosurgeon and the nerve ends were sutured, and a roentgenogram showed the nerve was still together.

The patient brought an action in the Circuit Court of Dane County, Wisconsin, against the surgeon for malpractice. A jury returned a verdict for the patient and the court entered judgment accordingly. The surgeon appealed.

The Supreme Court of Wisconsin affirmed the decision of the court below. The Supreme Court ruled that the surgeon was causally negligent as to the *lookout* he kept for the radial nerve. The Court declared: " . . . when performing an operation in the vicinity of such larger nerves, a physician should be more careful in his dissection so that if such nerves appear in sight, he can see and recognize them, and stay away from them."

HIGLEY VS. JEFFREY

Supreme Court of Wyoming

8 P. 2d 96

The surgeon performed an abdominal operation on the patient for protrusion of the uterus. During the operation a needle was lost, but, after a diligent search of twenty minutes, could not be found. Thereupon the incision made on the abdomen of the patient was sutured, and a roentgenogram was taken, which disclosed the fact that the needle was still in the abdominal region of the patient. The incision was reopened, the needle quickly removed, and the incision resutured. On the second day after the operation the patient died of pulmonary embolism.

The surviving husband of the patient filed an action in the District Court of Carbon County, Wyoming, against the surgeon. He claimed that the surgeon, by reopening the incision, performed a second operation on the patient; that such second operation was unauthorized, and that it was the proximate cause of the death of the patient. A jury returned a verdict in favor of the surgeon and the court entered judgment accordingly. The surviving husband appealed.

The Supreme Court of Wyoming sustained the decision of the lower court. The Supreme Court held that all that was done after the search for the needle, suturing the incision, taking the roentgenogram and reopening the incision, was, in the words of the Court, "a continuance of the search for the needle, which was commenced during the main operation, and it is hard to see, accordingly, how the reopening of the incision could be said to be a second operation."

PRACTICAL SURGICAL SUGGESTION

Non-irritating, Multipurpose Surgical Adhesive Tape

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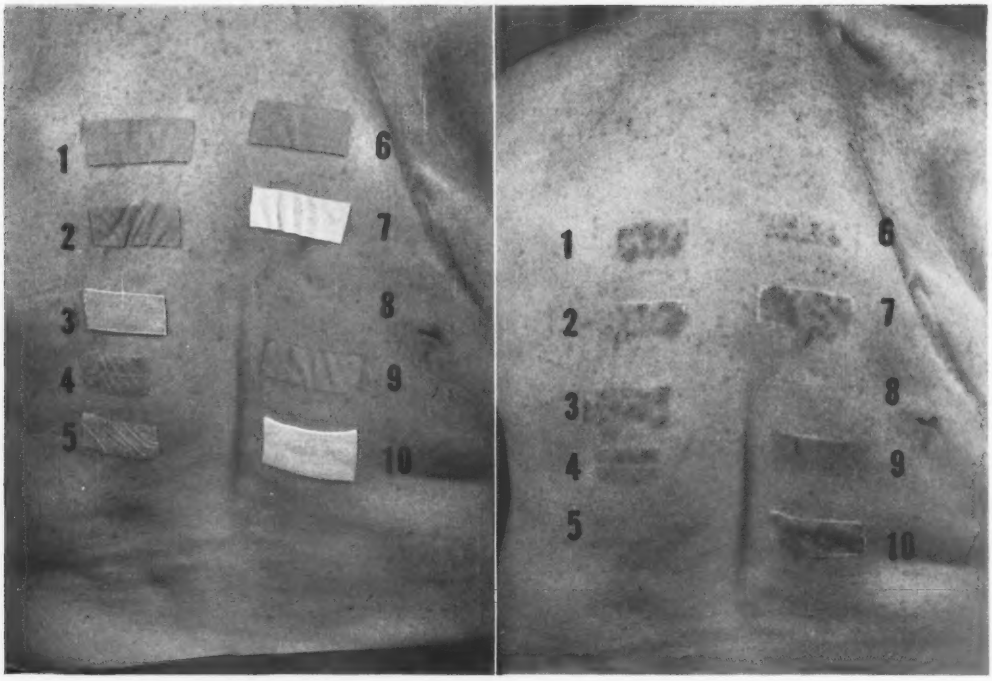
SURGICAL adhesive tapes, of one type or another, have been in use for more than twenty-five centuries and man has endured their inadequacies and frequent torments since the first crude formulation was applied to him. According to the Edwin Smith Papyrus, the Egyptians in 1600 B.C. applied strips of linen coated with flour of bean or barley, cream, honey or similar glutinous substances across gaping flesh wounds; linen, stiffened with plaster or gum, was used to hold fractured bones in place [2]. The Ebers Papyrus contains innumerable formulas for preparations undoubtedly intended as surgical adhesives, many combining bizarre and often socially offensive ingredients [3]. In Ancient Greece adhesives were compounded of olive oil, lead oxide and water, a mixture that continued in use until, with the addition of resin and yellow beeswax, the preparation became the "Emplastrum Resinae" of the early nineteenth century [20].

In the middle of the nineteenth century India rubber and, shortly thereafter, zinc oxide were added [7]. These offered a degree of improvement in the quality of surgical tapes but some surgeons remained dissatisfied with the results and conducted their own experiments with one formula after another [7,12,14]. Their failure to find a substance to satisfy the double criteria of long-lasting adherence with no skin irritation and the continuing failure of their successors is attested by the number of reports that have appeared periodically in the literature [5,9,12,13,18].

This writer became aware of the severity of the problem first in 1947 while engaged in devising a reliable enterostomy appliance. The collecting device of such an apparatus requires a secure bond to the skin and the adhesive furnishing such bond must be as nearly nonirritating as possible. All types of adhesive agents were examined but not one offered any practical advantage over another and all demonstrated the same relative degree of irritation, confirming the conclusion of other observers [5,18] that " . . . a certain amount of nonspecific irritation by adhesive plaster cannot be avoided."

The results of comprehensive studies to explain the manner whereby skin damage under adhesives occurred were published by a number of investigators [9,12,13] and specific additives, such as antihistamines [1], various complex drug preparations [8] and improved tape remover substances [4] were recommended in the interest of mitigating or eliminating the unhappy sequelae of adhesive tape application. A number of these new combinations, many with plastic backing of one type or another, were introduced and initially each seemed more useful and more effective than the one preceding. However, invariably each failed to provide a significant diminution in the incidence of skin irritation and subsequent reports continued to deal with the dermatologic complications as major disorders [15,19].

About five years ago a new type of double-faced adhesive disc, expressly designed for use with enterostomy devices, became available. Its superior adhesiveness promptly promised to be the solution for the unwieldy and insecure



1A 1B

FIG. 1. A, representative adhesive strips (1 inch by 2 inches) on the back of a patient who had previously reacted with severe irritation to conventional adhesive tape. The test areas are identified in accordance with the overlying strips, classified generally as: (1) water repellent, porous; (2) "flesh" plastic, nonporous; (3) elastic, porous; (4) clear plastic, porous; (5) experimental, microporous; (6) latticed, porous; (7) fabric, porous; (8) control area; (9) clear plastic, nonporous; (10) moleskin, nonporous. B, appearance of test areas immediately following removal of adhesive tape strips after six days. Absence of any irritation in area 5 corresponds exactly with the normal control area (8) where no adhesive was used.

applications then being accomplished by various types of liquid glues. But exciting even more interest was the demonstration that this adhesive, in direct contrast to all other preparations used, was remarkably nonirritating to the skin. With such evidence the manufacturer* scheduled additional research and development in this area to achieve the same benefits in a single-faced, roll construction adhesive tape.

The adhesive substance was a pure, synthetic copolymer ester which contained no additives and performed demonstrably as an inert material. From the start it was recognized that some type of porous or fenestrated construction for the backing would be essential. One of the requirements for satisfactory wound healing is a dressing which permits free evaporation of normal or abnormal secretions (perspiration, tissue fluid or exudate) [*16,17*]; interference with the physiologic activity of the skin soon results in the complications of irritation and maceration.

The first trial samples employed a polyethylene backing with large perforations distributed in staggered fashion throughout the roll of tape. Free ventilation certainly took place through the perforations but it was found that irritative changes often occurred in the intervening areas. Although these zones of irritation usually were not as severe as with ordinary adhesive tapes, the incidence of skin damage remained significant and it was obvious that gross porosity, in itself, was not the answer.

* Minnesota Mining and Manufacturing Company, St. Paul, Minnesota. (The type of nonirritating, synthetic adhesive referred to is described in that Company's U. S. Patent No. 2,884,126, issued April 28, 1959.)

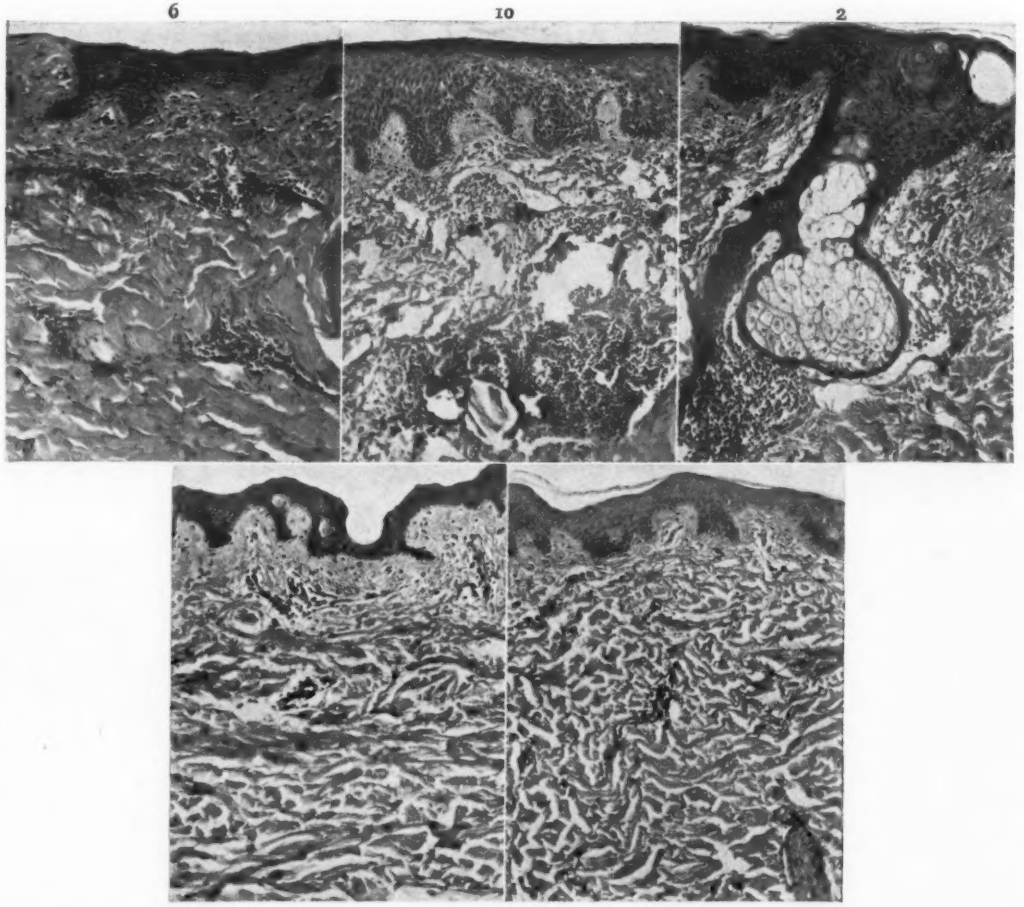


FIG. 2. Photomicrographs of biopsy specimens from representative test areas. The numbers correspond with those used in Figures 1A and 1B. Biopsies from areas 1, 2, 3, 4, 6, 7, 9 and 10 all showed some degree of inflammatory reaction. Biopsy specimen No. 6 exhibits the mildest changes, consisting of a few inflammatory cells in the corium. The most severe reaction appears in biopsy specimen 10, where a small abscess has developed and there is infiltration of many inflammatory cells. Biopsy specimen 2 demonstrates the average reaction in all other areas. Biopsy specimens 5 and 8 represent, respectively, the skin covered by the experimental tape under investigation and the normal skin without tape covering; they show no reaction at all.

A succession of other types of material for backing was tested, among them a porous, non-woven fabric constructed of rayon fibers. This fabric was coated with the adhesive in a special manner and the resulting surgical tape was offered for clinical trial early in 1959. Initially, there was little enthusiasm for what was generally regarded as a "tricky piece of paper smeared with glue." However, testing was continued and improvements made which eliminated the undesirable features until such excellent results appeared that a formal clinical survey was clearly indicated.

A detailed and ambitious program was organized to solicit objective appraisals of the tape from qualified investigators in several selected institutions in the New York metropolitan area. The hospitals included Doctors, Francis Delafield, Presbyterian Medical Center and St. Vincent's in New York City and the U. S. Veterans Hospital in East Orange, New Jersey. In addition, a number of surgeons agreed to use the tape in their office practices and report on their experiences. A coded form was developed to record patient's identification, diagnosis, type of application of the surgical tape, special condition of skin or wound, progress reports and pertinent data relating to results with other adhesives. Each record summarized the general performance of the experimental tape and its behavior under such special conditions as wet soaks, shower or bath, perspiration and cold or hot environment. Finally, there were spaces allotted for noting and evaluating ease of application and of removal, amount of residue and degree of patient satisfaction. The adhesive was offered in the usual widths of 1 inch to 4 inches for securing dressings, for strappings of all types and to retain prosthetic devices, intestinal and drainage tubes and infusion needles.

A number of patients having a previous history of severe skin irritation following the use of conventional surgical adhesive tapes were selected for special testing for comparative skin reaction. One inch by 2 inch strips of each of the types of adhesive tapes in general use were applied to the backs of these patients. These strips were affixed at random with an untaped, bare area designated as a control and were left in place for an average of six days. Typical results are shown in Figure 1. Differing degrees of skin irritation are present in each area covered by ordinary tape while in the area covered by the experimental tape and in the control area no departure from normal is discernible. Figure 2 shows photomicrographs of representative skin biopsies which confirm this gross interpretation.

These experimental results verified the clinical findings of all other investigators, namely, that an extraordinary freedom from skin reaction under this new type of adhesive tape was a consistent fact. Dr. Cushman D. Haagensen's report [6] summarizes the tenor of the observations submitted: "After using the tape for about a year, I have not seen a single instance of irritation of the skin caused by the tape." This crucial factor of absence of skin irritation or maceration highlighted the many other advantages of the experimental tape which soon became remarkable. It was possible to apply it directly over areas of drainage without obstructing the discharge, thus insuring against puddling of infectious or contaminated exudate. Secretions, perspiration, wet soaks and showering or bathing did not loosen or dislodge the tape. The persistent porosity of the backing permitted such prompt evaporation of fluids that the rapid drying effect at first was not clearly understood by a number of observers and gave rise to the erroneous belief that the tape was waterproof. It was found that application, even to hairy surfaces, was accomplished with intimate tenacity yet removal of the tape was surprisingly painless and no epilation occurred. Under ordinary usage the tape left no residue on the skin after removal and none of the adhesive mass crept beyond the tape edges. Even after prolonged application there were no reports of itching, burning, pulling or any other discomfort. If the tape surface became soiled, it could be cleansed with soap and water. From the patient's point of view the experimental adhesive was consistently and completely compatible with creature comfort.

Early in the clinical study blistering was observed at the edges of an adhesive dressing four days after it was applied to the abdominal incision following lumbar sympathectomy in a middle-aged, white male patient. This complication was so at variance with an impressively mounting experience to the contrary that the condition was scrutinized closely. On review of the patient's course it was found that he had suffered marked abdominal distention on the second postoperative day. The

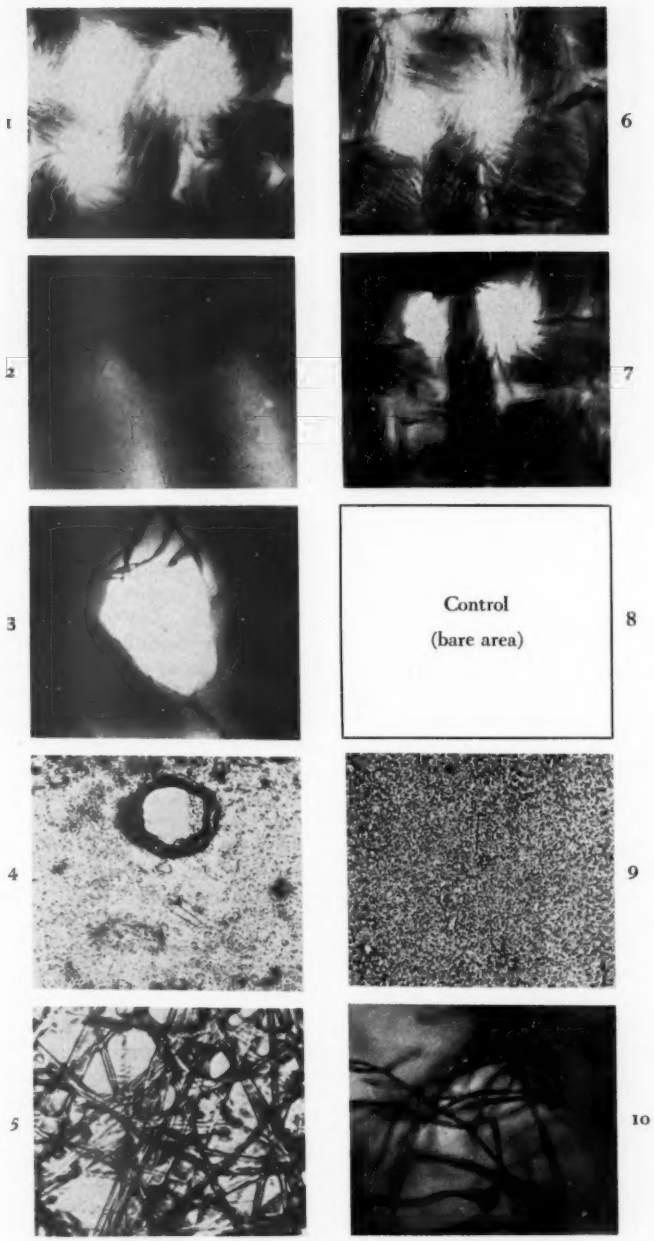


FIG. 3. Photomicrographs of all test tapes. The numbers correspond as previously and the contrasting, unique appearance of the microporous experimental adhesive tape is clearly shown. Original magnification × 100.

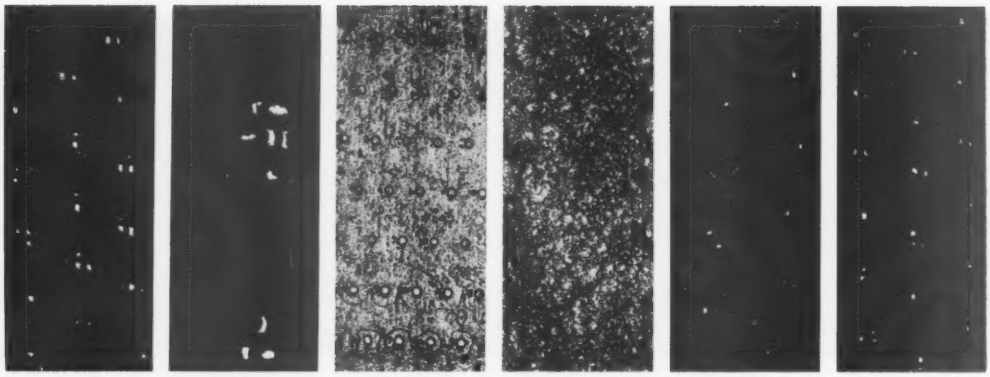


FIG. 4. Photomicrographs of the porous tapes, with numbers corresponding as before. The relationship between total area of air space (porosity) to total area of adhesive mass is easily recognized in each and explains why the experimental adhesive (5) remains unoccluded and persistently ventilated. Note plugging of most of the "pores" with adhesive substance in test strip 4 and the relatively inadequate number and distribution of perforations in the remainder of the "porous" tapes. Original magnification × 8.

relentless adherence of the adhesive unquestionably had been responsible for a shearing stress to the skin, terminating in a superficial, traumatic avulsion of the epidermis with transudate and vesiculation. This trauma was so benign, however, that the patient suffered no physical discomfort and stated there was no pain or tenderness in the blistered area. This same phenomenon was again observed several days later in a patient whose back was strapped for lumbosacral pain. With recognition of the mechanism of this complication, a simple preventive maneuver was carried out. By applying an additional strip of the adhesive perpendicularly across the ends of the primary strips (always applied without pressure or tension), with half the width extending beyond these ends onto the surrounding skin, the stress was dissipated; when this precaution was practiced wherever distention or a wide range of motion was anticipated, the problem was no longer encountered.

As the special properties of the experimental tape became apparent, specialized applications suggested themselves. The tape was found to be strikingly successful as a replacement for skin sutures in the apposition of wounds and lacerations of every description. The tape could be sterilized in strips by gas or steam autoclaving and handled with rubber-gloved fingers without transfer of adhesive or any significant difficulties in contact release. A sterile dressing kit, comprising a combination of sufficient gauze and adhesive to complete the average surgical dressing with no break in sterile technic, has been devised and is undergoing testing.

It was also found that the adhesive could be used to secure dressings in areas subjected to irradiation. Even after a full course of treatment no additional skin damage was created by the adhesive tape. The increased skin necrosis and ultimate tattooing which often follows irradiation through ordinary adhesives did not occur.

A series of investigations have been organized to assay the usefulness of the tape in other particular situations and will be reported in detail at a later date. Briefly, it can be stated now that specialized strappings of the trunk and extremities have been designed and worn by patients with such complete tolerance that desirable results were enhanced and accelerated. Certain technics in the field of plastic surgery have been modified and simplified with noteworthy effect. A program of reappraisal of the fundamentals of wound healing and the control of wound infection, specifically as influenced by unique applications of this surgical adhesive tape, already gives promise of some highly illuminating data. As an occlusive dressing and in the specialized field of patch testing, the tape has demonstrated singular advantages, and imaginative utilization in a broad range of dermatologic disorders should prove equally beneficial. Intial testing of ex-

perimental employment of the adhesive strips in the management of keloid or hypertrophic scar formation has exhibited important promise and is currently being expanded in scope. In the field of physical rehabilitation certain types of prostheses have been improved by combining the tape with other materials and these have been used with significant initial success in the treatment of a number of chronic conditions which previously were usually intractable and unresponsive to active management. These and similar investigations are presently under way and the results of each will be reported in turn as sufficient confirmatory data are accumulated.

It was apparent, when the pattern of consistent and notable performance by the adhesive was firmly established, that some logical and simple explanation of this achievement would be desirable. There was no difficulty in understanding the role played by the adhesive mass. This pure synthetic copolymer behaved as a physiologically inert substance, exercising a very mild effect on the skin despite its high coefficient of adhesion. It was an effectual substitute for the heavy combinations of plasticizers, fillers, solvents, anti-oxidants, resins, rubber and the like, of which other adhesive tapes are still composed. A specific contribution by the backing material was also conjectured and immediately confirmed by microscopic examination of all the adhesive tapes studied. Figures 3 and 4 clearly reveal a marked difference in construction, particularly in comparison with the porous tapes. The experimental tape is *microporous* with a labyrinthine or honey-combed fenestration providing a profusion of unobstructed air ways. This is accomplished by a technically novel process whereby the fibers of the random web of the backing are coated with a very fine film of adhesive in such a manner that none of the mass coalesces or otherwise occludes the air spaces. The extremely thin spattering of the adhesive remains firm and does not tend to liquefy under external or intrinsic temperature elevations. Consequently, the adhesive substance does not flow around or engulf the roots of the hairs, transfer to the skin or permit creep. Therefore, too, its removal is painless with very little or no residue and no loss of hair.

One would ordinarily hesitate to publish such a large number of outstanding claims for a surgical essential noted for its irascible behavior. However, these claims represent the results of objective observations and should be readily confirmed with more widespread distribution and use of this adhesive tape.

CONCLUSIONS

A new surgical adhesive tape has been developed, tested comprehensively under severe scrutiny and found to provide the following desirable properties, effects and advantages:

1. No skin irritation or maceration occurs.
2. The microporous construction allows unhampered ventilation and drainage with free evaporation of underlying fluids.
3. The adhesive mass is a thin, spattered coating of an inert synthetic substance which remains firm, does not liquefy and flow or creep under the influence of temperature elevations.
4. It combines maximum ease in handling with the highest coefficient of adhesion, yet yields to painless removal without epilation and with little or no residue.
5. Sterilizable by standard methods, it is easily manipulated with the rubber-gloved fingers and useful in a variety of operative technics including wound closure.
6. It is not dislodged by secretions, perspiration or soaking.
7. No reactivity, inflammation, tattooing or other similar complications occur under irradiation.
8. It is completely compatible with patient comfort.

SUMMARY

1. A brief reference to the history of surgical adhesive tapes confirms the opinion that at no time in the past has the employment of this indispensable surgical implement ever been consistently free of some associated skin damage.

2. The development of a new surgical adhesive tape is presented.

3. The extent and scope of the clinical survey of this experimental tape is summarized with an analysis of initial results.

4. Additional investigations of the tape's many potentialities are mentioned and will be reported in full at a later date.

5. The unusual composition and construction of the tape is described and illustrated to

explain its radically different performance in comparison with conventional adhesive tapes.

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Our Surgical Heritage

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JEAN LOUIS PETIT

JEAN LOUIS PETIT (Petit's triangle) was born in Paris in 1674. At approximately seven years of age he became attached to the anatomist Littré, for whom Littré's hernia is named. Petit assisted in making dissections for the lectures of Littré and was in charge of the anatomic amphitheater. At the age of sixteen he became a pupil of the Paris surgeon, Castel.

In 1692, Petit performed surgery in two campaigns with the Marshal of Luxembourg. His dexterity became evident in France. In 1700 he was appointed Surgeon in Chief of the military school in Paris. It was at this period that he began the preparation of his great book, *The Diseases of the Bones*, and delivered lectures on operative surgery which drew most of the distinguished surgeons of Europe to his operating amphitheater. In 1700 he received the degree of Master of Surgery from the Faculty of Paris. His inventiveness is demonstrated in one instrument, Petit's tourniquet.

In 1715 he was made a member of the Royal Academy of Sciences and an honorary member of the Royal Society of London. He was appointed by the King to the position of Director General of the Royal Academy of Surgery.

Petit's most important work was, "A Treatise on Surgical Diseases and the Operations Which Are Proper for Them" (1774). He was one of the first to perform cholecystotomy and also mastoidotomy.

Jean Louis Petit holds an equal place with Ambroise Paré in French surgical achievements. He died in 1750.

The Diagnostic Corner

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The approach to the problem of differential diagnosis of a "cystic lesion" in the posterior portion of the left hemithorax.

THIS seventy-four year old white woman had been admitted to the Ohio State University Hospital about one month earlier with intermittent crampy pain in the epigastrium and the left lower quadrant for the three previous months. She was put on a weight-reducing diet because of obesity and an upper respiratory infection, and was told to return for a more complete work-up when she recovered from the respiratory infection. A barium enema performed elsewhere had shown no intrinsic lesion.

She returned to the hospital for further work-up, at which time she was in no acute distress. All vital signs were within normal limits. The chest was clear on physical examination. The abdomen was obese, soft and non-tender. No masses were palpable. Laboratory studies showed the hemoglobin to be 12.3 gm., with a normal white blood count, prothrombin time, urinalysis and blood volume studies. Blood urea nitrogen was 12 mg. per cent. No free acid was noted in the twelve-hour gastric sample. A roentgenogram of the chest was taken (opposite) showing a large thick-walled cystic lesion in the posterior portion of the left hemithorax. This lesion contained an air fluid level in its inferior portion. *What is your diagnosis?*

Please turn page for answer

Diagnosis: Hiatus hernia, large, with upside-down stomach

The roentgenographic findings should certainly suggest the possibility of a large gastric hiatus hernia when a large cystic structure is observed behind the heart, particularly if it contains air and fluid. Such a lesion is seen in the posterior portion of the left hemithorax on the chest film taken of this patient. A barium study of the upper gastrointestinal tract is mandatory because hiatus hernia is the most likely diagnosis when this appears on regular roentgenograms of the chest. The larger the hiatus hernia, the greater the chance of volvulus and subsequent closed-loop obstruction. Also hiatus hernias are sometimes the source of serious gastrointestinal bleeding. When a cystic-appearing lesion such as this is observed, it is of great practical importance to do "first things first." It is wisest to perform the gastroduodenal examination before others. It would be unwise to perform bronchoscopy or bronchography first because they are the more difficult procedures to perform and most difficult for the patient to tolerate.

Of great interest was the fact that a carcinoma of the left transverse colon was found at surgery. This was unsuspected in view of the previous history of a normal barium enema elsewhere a short time before the patient was admitted to our institution. The carcinoma was successfully removed and splenectomy and transverse colectomy were performed at the same time that the large hiatus hernia was repaired. The patient's postoperative course was completely uneventful. She was discharged on the nineteenth hospital day.

In summary, the three most important lesions to consider in the differential diagnosis of retrocardiac cystic lesions containing air and fluid are (1) hiatus hernia, (2) HIATUS HERNIA and (3) HIATUS HERNIA! The first diagnostic study to perform in a patient with a retrocardiac cystic lesion is the barium study of the esophagus and stomach.

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Management of Burn Deformity of a Hand

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A SIXTEEN year old white boy, E. W. A., was in an automobile accident and gasoline fire while on vacation. He received third degree burns on both ears, left side of the face and neck, left axilla, left side of the chest and the dorsum of the left hand and fingers. Wound infections occurred and multiple skin grafts were required. He was hospitalized for two and a half months. Because of "keloid" formation and contraction deformities, he could not use his left hand for grasping. (Fig. 1A.)

PHYSICAL EXAMINATION

The patient was an obese, young boy weighing 225 pounds. Blood pressure was 142/80 mm. Hg; pulse, 80 per minute; respirations, 18 per minute; and temperature, 98.6°F. The important findings were limited to the left hand. The metacarpophalangeal joints were hyperextended by scar contraction. All web spaces were bridged with scars along the dorsal folds. The longitudinal and transverse arches of the hand were lost. The thumb had marked adductor contraction and was functionless. All fingers maintained an attitude of flexion. (Fig. 1A.)

LABORATORY DATA

Hemoglobin was 14 gm. per cent; hematocrit, 45 per cent; white blood count, 9,300 per cu. mm. (neutrophils 62 per cent). Examination of the urine demonstrated no abnormalities. Blood serology was non-reactive. Fasting blood sugar was 77 mg. per cent.

SURGERY

The patient was given general anesthesia. A pneumatic tourniquet was placed on the left arm. The scar on the dorsum of the left hand was excised from the wrist to the metacarpophalangeal joints. Care was taken to preserve the veins and nerves. The thumb web was incised from the joint level dorsally to the joint level on the volar surface. The edges were incised in a zigzag manner. The third web space was incised in a manner similar to the thumb web.

The pneumatic tourniquet was released and bleeding points were controlled with an electric coagulator and No. 5–0 plain catgut ties. Split-skin grafts, twenty to twenty-five $\frac{1}{1000}$ of an inch, were sutured to the defects. Adaptic gauze and stents were tied over the skin grafts. Fluff gauzes were used to separate the fingers and for dressings. A pressure dressing was applied, and a volar plaster splint was used to maintain the hand in a functional position. The donor site was dressed with a pressure dressing.

FURTHER COURSE

No fever or other signs of infection was present after the operation. He was followed up as an outpatient after the fifth postoperative day. The sutures were removed in one week. A pressure dressing was kept on the hand for ten days. The wounds healed well. Dynamic splinting was used to aid in flexing the metacarpophalangeal joints. Dressings were removed from the donor area after two weeks. and healing was complete.

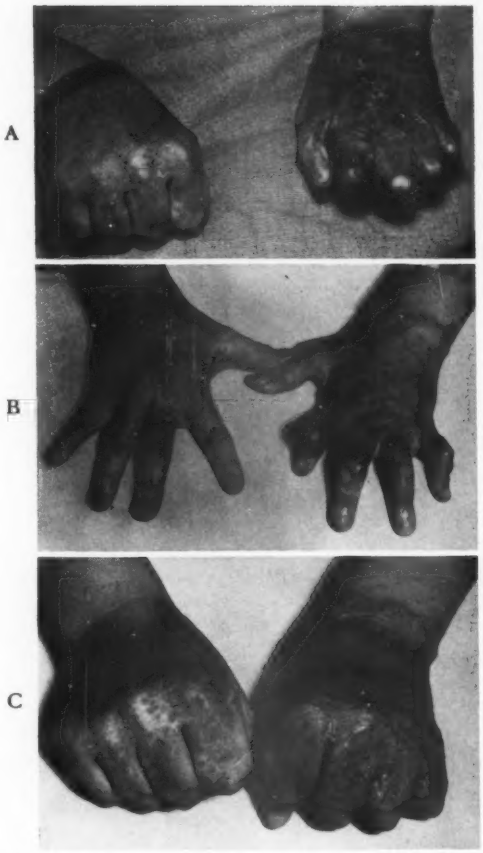

FIG. 1. A, Burn contraction of the dorsum of the hand showing an attempt to make a fist. Note contracted web spaces. B, Left hand is open and thumb is abducted. Web spaces are repaired. Note the boutonnière deformities which are to be repaired later. C, Burn contractions have been repaired. A normal fist is made with the left hand. No blanching of the skin is present over the knuckles.

SECOND OPERATION

About one month after the first operation, the patient was readmitted and taken to the operating room, where general anesthesia was given. A pneumatic tourniquet was used on the left arm. The second and fourth web spaces of the left hand were incised in a zigzag manner from the joint area dorsally to the joint area ventrally. Care was taken to remain clear of digital vessels and nerves. The tourniquet was removed, and hemostasis was obtained with the electrocoagulator and No. 5–0 plain catgut ties. Split-skin grafts, about twenty $\frac{1}{1000}$ of an inch, were used to close the defects. Adaptic gauze and stents were tied over the skin grafts. A pressure dressing was applied. The hand was maintained in functional position with a volar plaster splint.

FURTHER COURSE

There was no fever or other signs of infection after the operation. The patient was followed up as an outpatient after the third postoperative day. The stitches were removed in one week and the pressure dressing in ten days. Dynamic splinting was used again. The function of the hand improved progressively. The patient was using his hand well by the sixth month. (Figs. 1B and C.)

COMMENTS

The case reported herein outlines the management of severe deformity of the hand caused by "keloid" formation and burn contractions of the hand. The original poor results are caused by complications of infections in early treatment.

Contraction scars of the hand are removed in an avascular field, using a pneumatic tourniquet. All plaques and scar tissues are excised with careful dissection of the deeper extensions of the scars. These deeper extensions of scars have a major role in causing contractions.

Zigzagging of the edges of skin is performed in web spaces and when incision crosses normal wrinkle lines. Straight lines are not made across normal wrinkle lines because these produce contractions.

Thin skin grafts are satisfactory for temporary covering of burned hands. Permanent covering with split grafts, twenty to twenty-five $\frac{1}{1000}$ of an inch, are preferable. No covering of the hand is ever as good as the original skin. Skin grafts are held in place with ties over stents and covered with pressure dressings. Immobilization of the graft is necessary for satisfactory healing.

In secondary surgery of webs of the hand, it is thought best to incise only alternate webs first and the others at a later date. Zigzags along the sides of the fingers break up straight lines and prevent contractions from developing. It is important to open the web spaces from the joint area dorsally to the joint area ventrally in order to give full range of motion of the fingers when healing is complete.

Immobilization in functional position is preferred when grafts are placed on the dorsum of the hand.

Dynamic splinting with flexible bands is probably the best physiologic method of regaining full range of motion in the joint. Sudden and excessive forces on poorly functioning joints may cause hemorrhage of the capsules and permanent damage to the joints.

When the central bands of extensor mechanism over the proximal interphalangeal joints are severely damaged, the damage is usually permanent. The lateral tendons to the distal phalanx are allowed to slide ventrally and an attitude of flexion, or boutonnière deformity, is maintained. Fusion of such joints in the maximum position of function probably gives the best results. Bunnell [1] mentions approximating these tendons in the mid-dorsal line, but this procedure has not been perfected as yet.

If the burn on the dorsum of the hand is deep enough to involve the tendons, a flap is usually necessary to regain maximum function of the hand.

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